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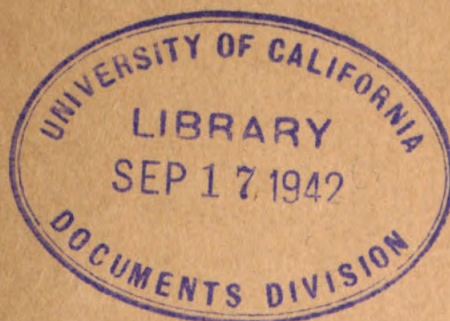
**TM 9-235**

WAR DEPARTMENT

*U.S. Dept of Army*  
**TECHNICAL MANUAL**

**37-MM AA GUN MATÉRIEL**

**May 16, 1942**





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TECHNICAL MANUAL }  
No. 9-235

WAR DEPARTMENT,  
WASHINGTON, May 16, 1942.

## 37-MM AA GUN MATÉRIEL

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\*This manual supersedes TM 9-235, December 31, 1940, and Training Circular No. 17, War Department, 1941.

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## SECTION I

### GENERAL

Scope-----	Paragraph 1
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**1. Scope.**—*a.* This manual is published for the information and guidance of the using arms and services.

*b.* In addition to a description of the 37-mm antiaircraft matériel, this manual contains technical information required for the identification, use, and care of the matériel.

*c.* Disassembly, assembly, and such repairs as may be handled by using arms personnel will be undertaken only under the supervision of an officer or the chief mechanic.

*d.* In all cases where the nature of the repair, modification, or adjustment is beyond the scope or facilities of the unit, the responsible ordnance service should be informed in order that trained personnel with suitable tools and equipment may be provided, or proper instructions issued.

**2. Characteristics.**—The 37-mm antiaircraft gun is a full automatic weapon. The gun is mounted on a four-wheeled trailer carriage capable of being towed 50 mph on good roads. By means of counterpoise cylinders the chassis is lowered to the ground for firing and is raised to the wheels for traveling. Antitank firing as well as antiaircraft firing is possible with this matériel. Two caliber .50 machine guns mounted on the M3E1 carriage may be fired simultaneously with the 37-mm gun.

### **3. Carriage data.**

Item	M3	M3E1	M3A1
Guns-----	1 37-mm AA automatic gun M1A2.	1 37-mm AA automatic gun M1A2 and two cal. .50 Browning machine guns M2, water-cooled, flexible.	1 37-mm AA automatic gun M1A2.
Carriage chassis.	4 wheeled towed vehicle type	Same as M3.	Same as M3.



Item	M3	M3E1	M3A1
Brakes-----	Disk and lever type electric brakes on 4 wheels. Hand brakes on rear wheels.	Same as M3.	Same as M3.
Leveling mechanism.	Tilts through a range of 10°. Operated by two hand-wheels.	Same as M3.	Tilts through a range of 10°. Operated by 2 ratchet wrenches secured to the leveling mechanism.
Elevating mechanism.	Two speed ratios available for 0°-85° limit elevation. Hand operated only. One turn of handwheel elevates 3.75° in slow ratio and 11.25° in fast ratio.		One speed ratio. Hand and power operated. Mechanical stops at -5° and 90°. Automatic stop switch for power operation at 0° and 85°. One turn of handwheel elevates 4.67°.
Traversing mechanism.	Two speed ratios available for 360° traverse. Hand operated only. One turn of handwheel traverses 3.75° in slow ratio and 11.25° in fast ratio.		One speed ratio. Hand and power operated for 360° traverse. One turn of handwheel traverses 6°.
Equilibrator---	Equilibrator connected to cradle by means of a rod.	Same as M3.	Equilibrator connected to cradle by means of a rod and a chain.
Firing mechanism.	Cam and lever arrangement operated by a foot pedal.	Same as M3 carriage for the 37-mm gun. Separate pedal for cal. .50 machine guns.	A lever and cable arrangement operated by 2 foot pedals. Adjustment provided for semiautomatic or automatic firing.
Outrigger assembly.	Pivots about a bracket centrally located on each side of the chassis. Stands upright for traveling.	Removed from bracket and carried alongside the chassis for traveling.	Same as either M3 or M3E1 carriage.



Item	M3	M3E1	M3A1
Cradle.....	Open frame construction.	Open frame construction contains brackets for attachment of two cal. .50 machine guns.	Frame construction with top, bottom, and front removable covers.
On-carriage fire-control equipment.	Sighting system M2 and telescopes M7.	Sighting system M2 and telescopes M7.	Remote control system M1 and direct fire sights.
Weight, complete, pounds.	5,300.....	5,600.....	6,100.
Rate of fire, rounds per minute.	120.....	120 for 37-mm gun 650 for cal. .50 machine gun.	120.
Over-all length (traveling position)—inches.	241.....	241.....	241.
Over-all width (traveling position)—inches.	69.5.....	69.5.....	69.5.
Tread—inches.	58.....	58.....	58.
Wheelbase—inches.	120.....	120.....	120.
Height (traveling position)—inches.	80.5.....	80.5.....	72.
Height of trunnions above ground—inches.	33.....	33.....	54.5.
Road clearance—inches.	11.....	11.....	11.
Tire size.....	5.50-18.....	5.50-18.....	5.50-18.
Tire inflation — pounds per square inch.	38.....	38.....	38.



**4. Gun data.—a. Gun, 37-mm, M1A2:**

Weight of gun, complete	pounds	365.
Length of gun, complete	inches	104.
Weight of tube	pounds	119.
Length of tube	inches	78.
Length of bore	calibers	53.53.
Life of tube	rounds	2,000.
Muzzle velocity	feet per second	2,600.
Rate of fire	rounds per minute	120.
Type of breechblock		Vertical sliding.
Recoil mechanism		Hydro-spring.
Length of recoil	inches	10 $\frac{3}{4}$ .
Recoil fluid		Oil, recoil, light.
Recoil fluid capacity	pints	3 $\frac{1}{2}$ .
Maximum vertical range (HE shell)	yards	6,200.
Maximum horizontal range (HE shell)	yards	8,875.
Vertical range, self-destructing (HE shell)	yards	3,960.
Horizontal range, self-destructing (HE shell)	yards	4,070.
Weight of high-explosive projectile	pounds	1.34.
Weight of armor-piercing projectile	pounds	1.9.
Maximum number of rounds permitted to be fired before cooling	rounds	100.
Weight of 1 round, shell, HE, M54	pounds	2.62.
Weight of 1 round, shot, AP, M59	pounds	3.12.
<i>b. Gun, machine, caliber .50, Browning, M2, water-cooled, flexible:</i>		

Weight of gun with water, 36-inch barrel	pounds	110.00.
Weight of gun with water, 45-inch barrel	do	121.50.
Weight of gun without water, 36-inch barrel	do	94.00.
Weight of gun without water, 45-inch barrel	do	100.50.
Weight of barrel assembly, 36-inch barrel	do	14.50.
Weight of barrel assembly, 45-inch barrel	do	17.08.
Over-all length of gun, 36-inch barrel	inches	57.00.
Over-all length of gun, 45-inch barrel	do	65.93.
Number of grooves in barrel		8.
Rate of automatic fire	shots per minute	500-650.
Chest, ammunition, caliber .50, M2, empty	pounds	29.
Chest, ammunition, caliber .50, M2, loaded	do	89.
200 links, caliber .50	do	8.
200 cartridges, caliber .50, M1	do	52.

## SECTION II

## DESCRIPTION AND FUNCTIONING OF GUN

	Paragraph
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**5. General.**—The 37-mm automatic gun M1A2 is a recoil-operated weapon using an ammunition clip carrying 10 rounds. The cartridges are fed into the left side of the feed box, the empty cases ejected through a longitudinal opening below the trunnion block, and the empty clip ejected through an opening in the right side of the feed box. Sustained fire is possible, since a new clip of ammunition may be fed into the mechanism without interruption of the firing.

**6. Major assemblies.**—The entire gun (figs. 1, 2, and 3) depends for its operation upon the functioning and proper relationships of the following major assemblies:

- a. Trunnion block.
- b. Feed box.
- c. Tube and tube extension.
- d. Lock frame assembly.
- e. Recuperator.
- f. Driving spring assemblies.
- g. Back plate assembly.

**7. Trunnion block (fig. 1).**—This section of the gun mechanism is a rectangular casing open at the top and front and partly open at the bottom. The feed box is secured to the top of the trunnion block. The tube extension fits in the center of the block and projects through the front opening, at which point the gun is threaded and locked into the tube extension. The bottom of the trunnion block is flanged inward on each side to support the tube extension and lock frame, but it contains an opening large enough to permit ejection of the empty cartridge cases. In the back the trunnion block contains the slide in which the back plate assembly is secured.



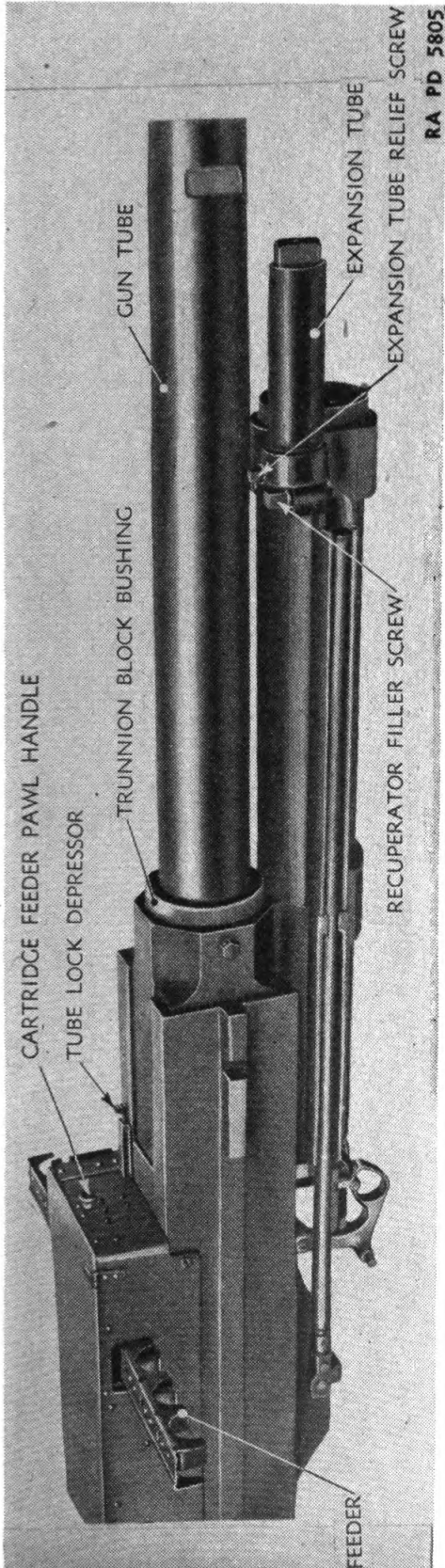


FIGURE 1.—Right front view of gun with feeder in place.

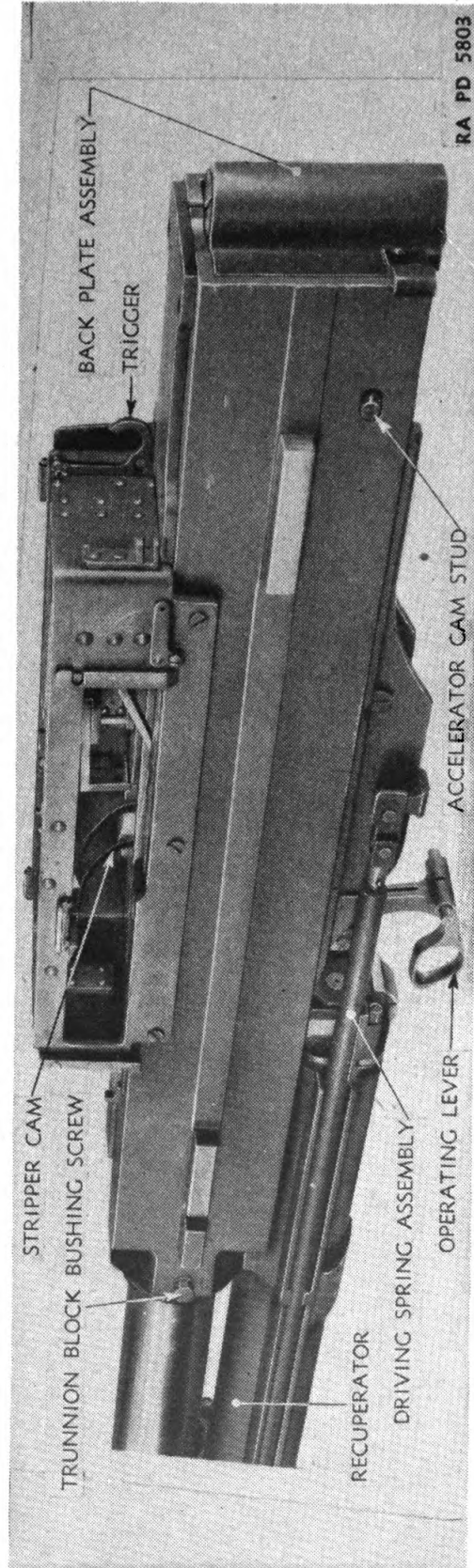


FIGURE 2.—Left rear view of gun.

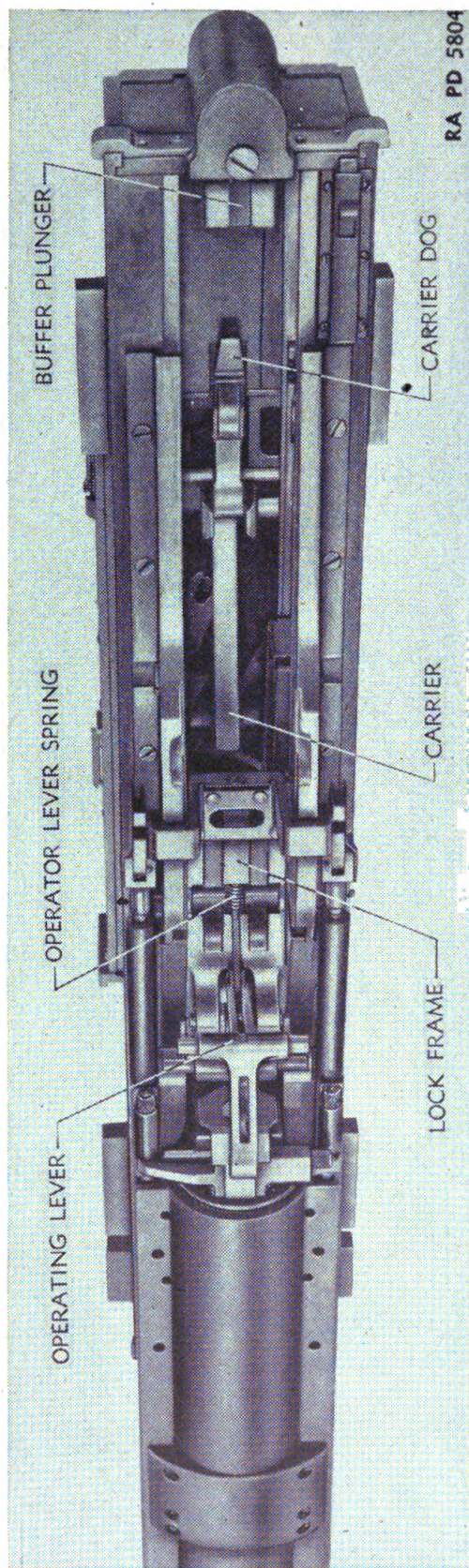


FIGURE 3.—Bottom rear view of gun.



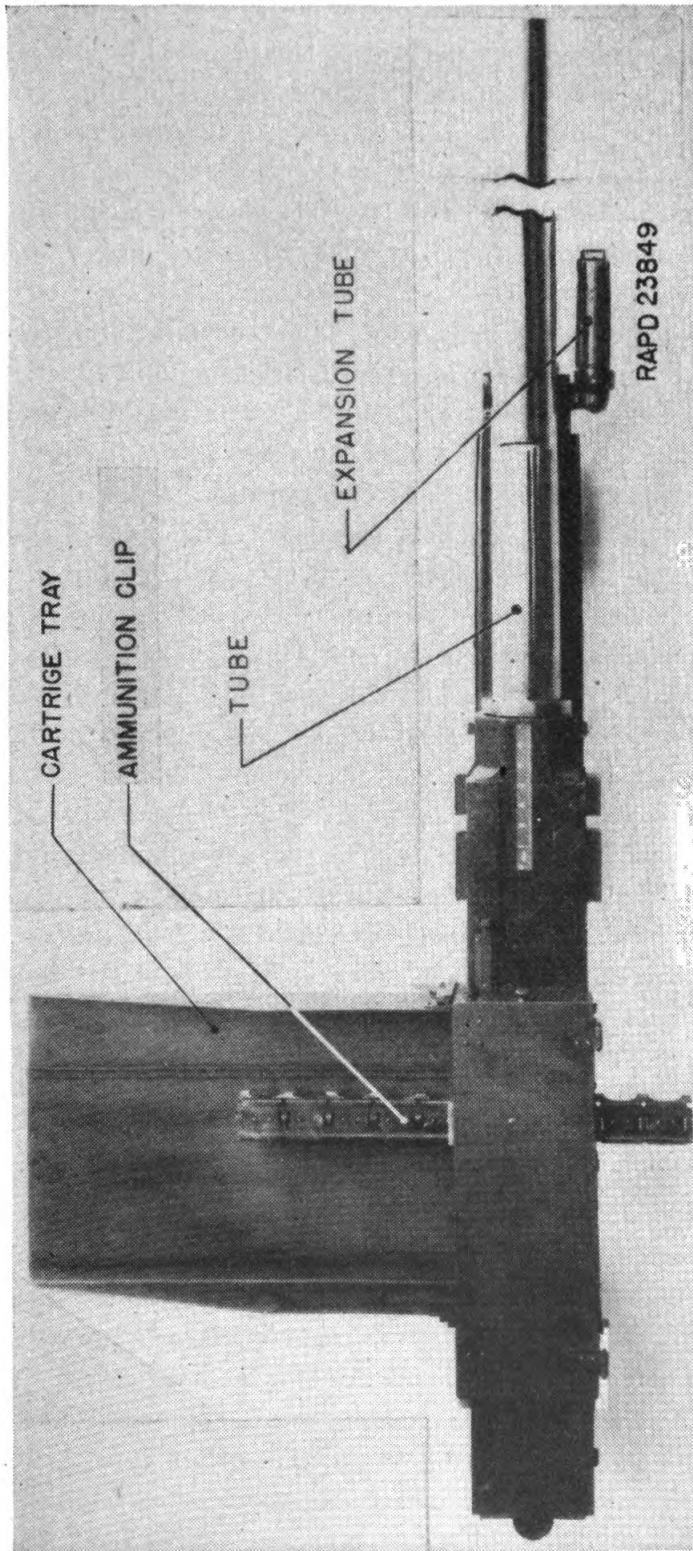


FIGURE 4.—Top view of gun and cartridge tray.



**8. Feed box.**—*a. Ammunition clip and cartridge tray.*—The cartridge tray snaps to the left side plate of the feed box and supports the loaded ammunition clip as it feeds into the gun. The ammunition clip (fig. 4) is a long, narrow channel-shaped piece to which are riveted 10 spring clips. One round of ammunition is held by each spring clip. The loaded clip is fed into the gun through the opening in the left side plate of the feed box. The feed box mechanism automatically removes the rounds from the clip and moves the clip out of the feed box through a hole in the right side plate.

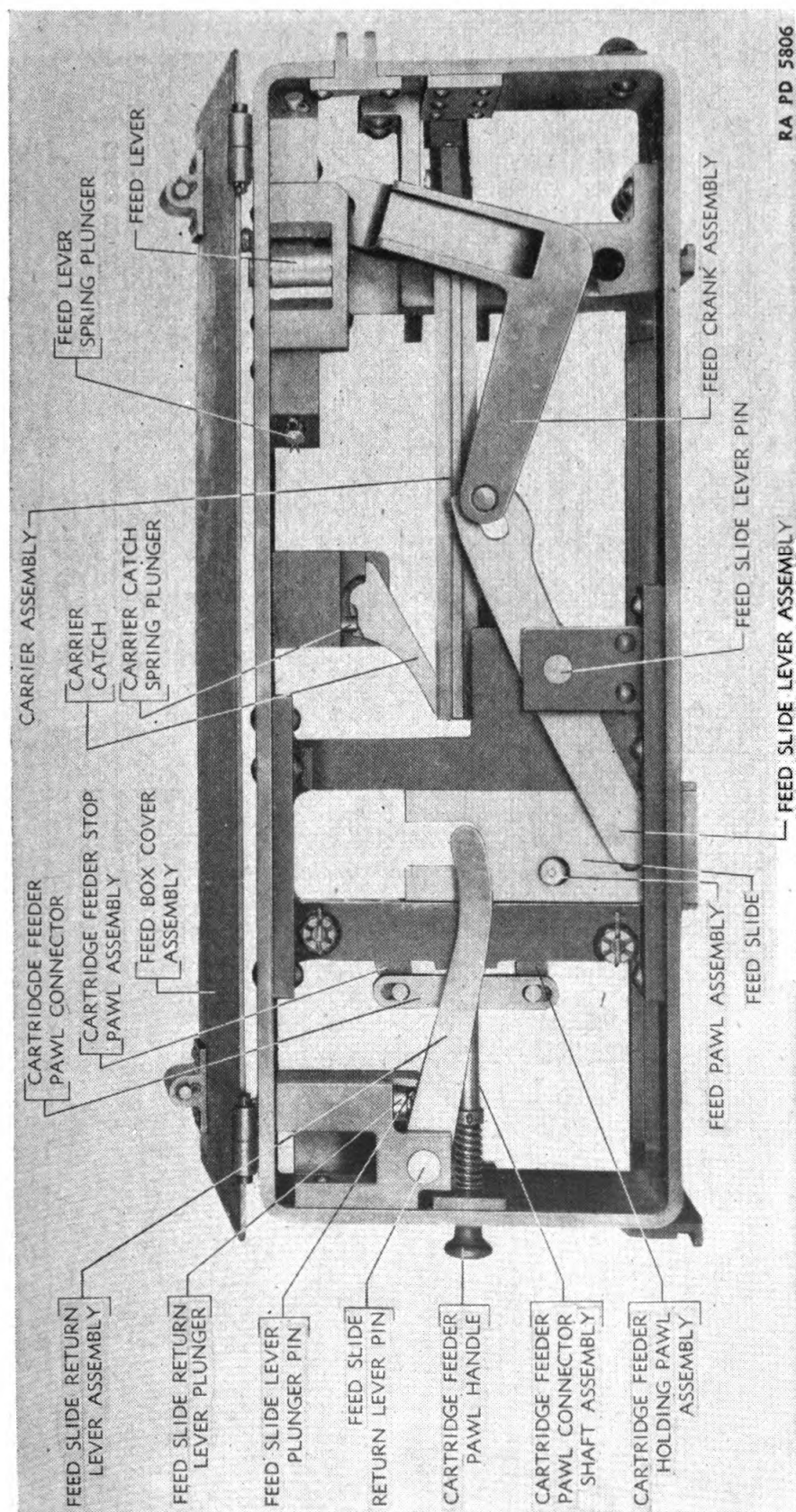
*b. Feed box mechanism* (fig. 5).—The feed box, a rectangular box-like structure about half the length of the trunnion block, is fastened to the top of the trunnion block and approximately centered on it. The feed box has an opening in its left side plate through which the cartridge clip enters, and a smaller opening in the right side plate through which the empty clip is ejected. The top of the box has a hinged cover that may be opened so that it will hang over the right side of the feed box. A set of levers, links, and pawls which are housed in the feed box govern the motion of the ammunition clip and remove the rounds from it. The important parts of the feed box mechanism function as described below. Figures 6 and 7 show the parts at the beginning of the feed stroke and end of the feed stroke.

(1) *Feed lever.*—This is a long pointed lever pivoted to the top right rear portion of the feed box. The lever, which normally points toward the lower rear part of the gun and is engaged to the feed crank by means of a swivel stud, is pushed forward by a stud on the tube extension during counterrecoil of the tube extension (par. 9). In this manner the feed lever initiates the action of the feed box mechanisms which bring the next round into the gun.

(2) *Feed crank.*—This is a large right-angled lever which transmits the motion of the feed lever to the feed slide lever.

(3) *Feed slide lever.*—This lever transmits the motion onto the feed slide and feed pawl assembly.

(4) *Feed slide and feed pawl assembly.*—These two parts move together in a slideway just below the upper surface of the feed box. The lower surface of the feed pawl has a projecting edge which engages mating slots in the cartridge clip. As the feed slide and feed pawl are moved to the right by the feed slide lever, the feed pawl pushes the cartridge clip to the right, thus carrying another round into the mechanism. The feed slide and feed pawl then slide back over the clip without moving the clip. Figure 8① shows the feed slide and feed pawl moving the ammunition clip to the right and figure 8② shows the feed slide and feed pawl moving back over the clip without moving the clip.



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FIGURE 5.—Top view of feed box assembly.

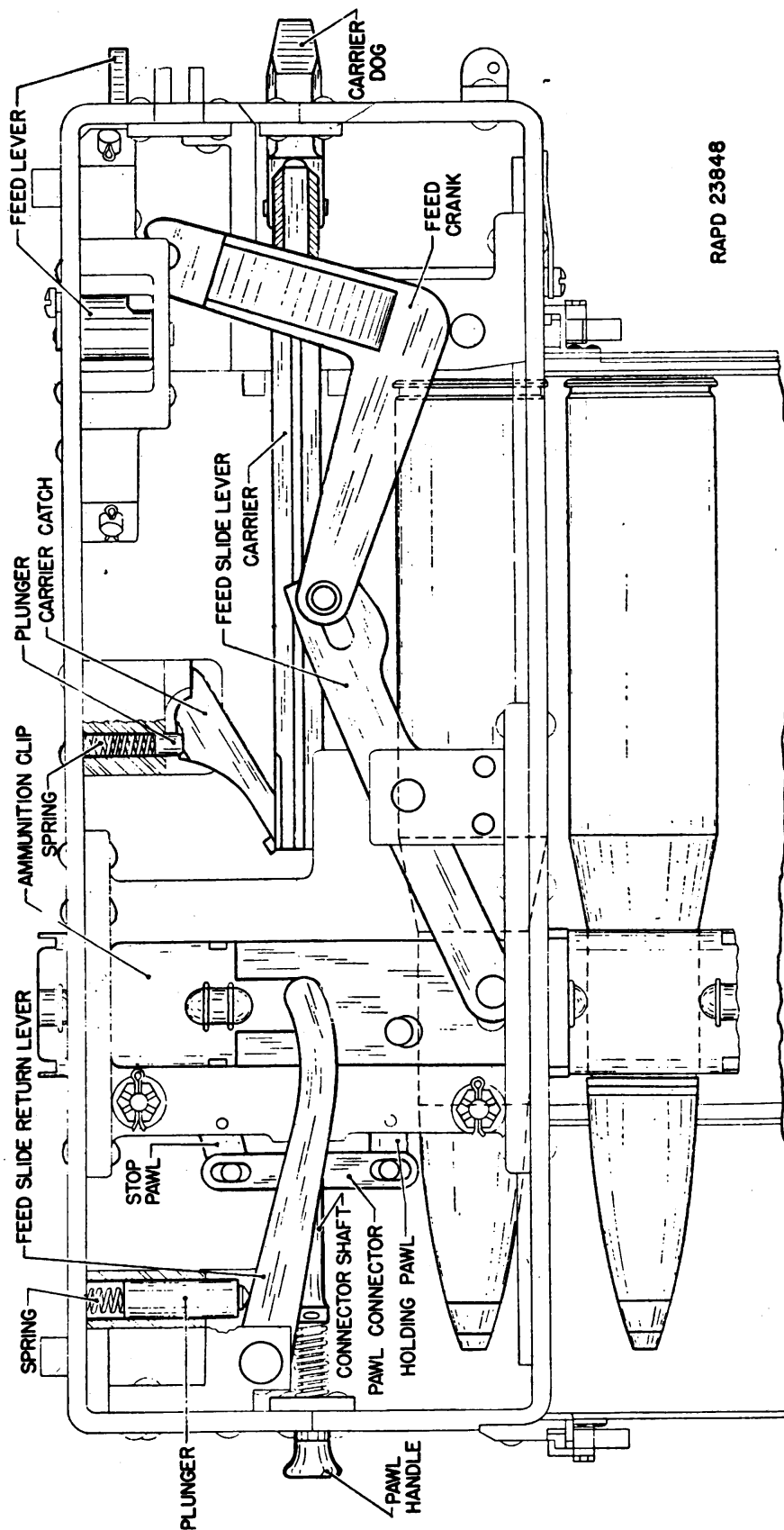
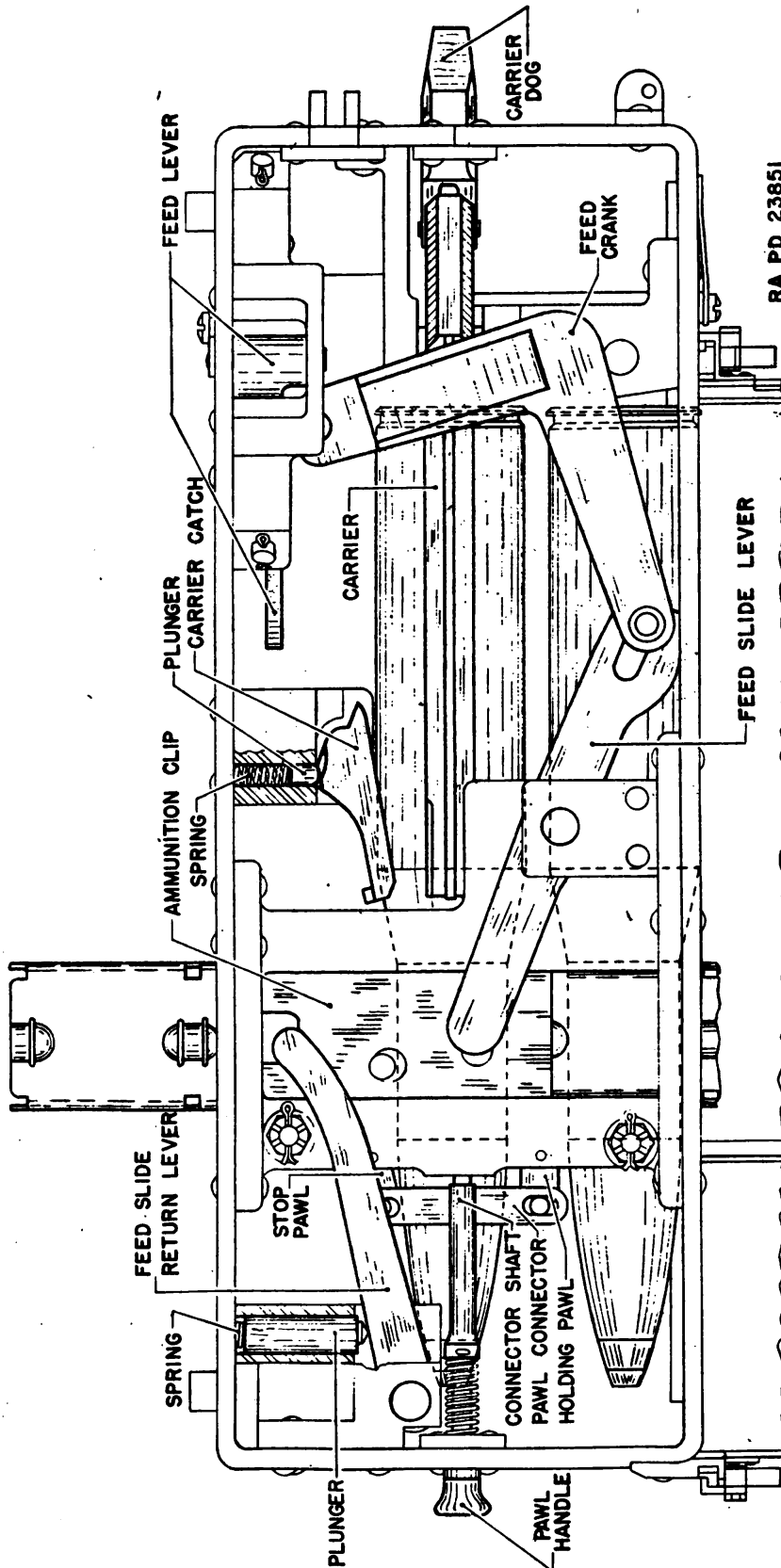


FIGURE 6.—Position of feed box mechanisms at beginning of feed stroke.

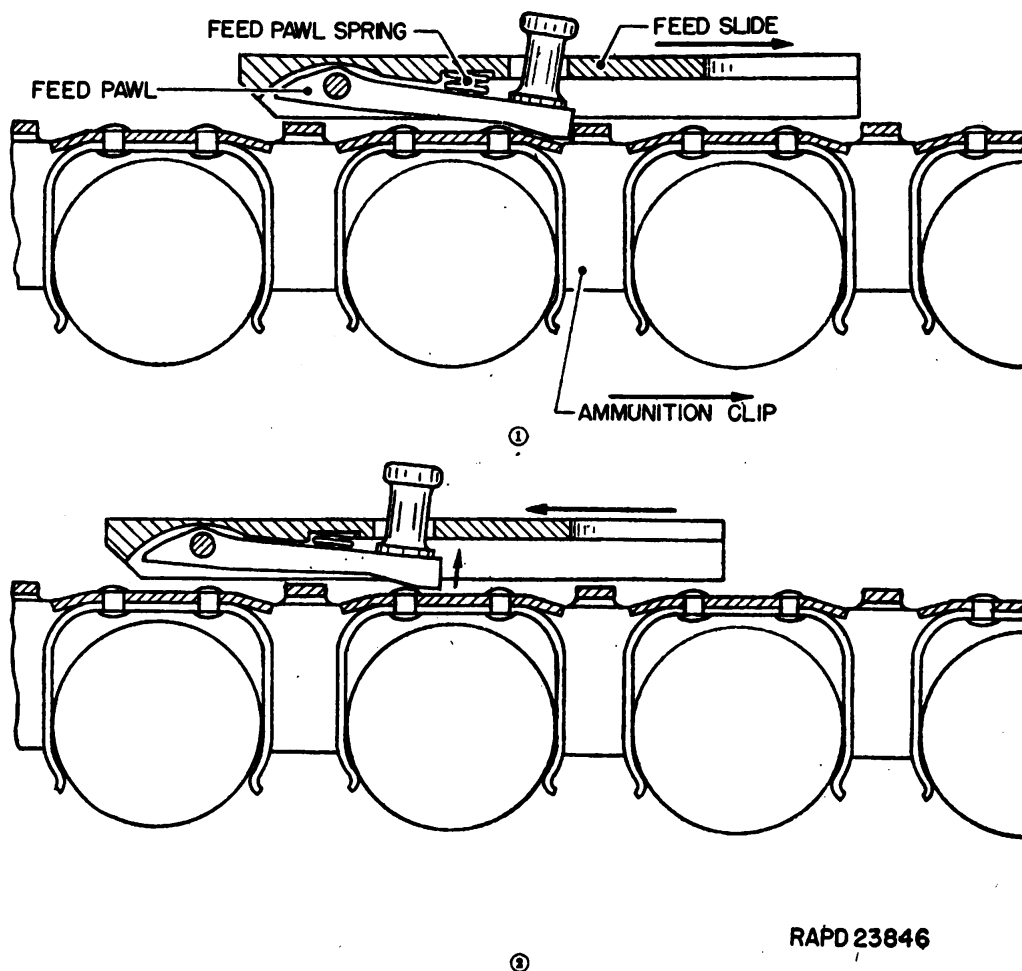


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FIGURE 7.—Position of feed box mechanisms at end of feed stroke.



(5) *Feed slide return lever.*—This is a long lever which pivots about a point in the upper front right-hand corner of the feed box. This lever is pushed to the right by the motion of the feed slide and feed pawl assembly. The lever compresses a spring and plunger which, at the end of the stroke, cause the lever to move the feed pawl and feed slide assembly back to the left. This in turn causes the feed slide lever, feed crank, and feed lever to return to their original positions. This



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FIGURE 8.—Function of feed slide and feed pawl assembly.

action takes place after the feed lever operating stud has pushed the feed lever to its limiting forward position.

(6) *Cartridge feeder holding pawl and cartridge feeder stop pawl assemblies.*—These pawls are secured to the right and left ends of the slideways for the feed slide and feed pawl (fig. 5). Toward the end of the motion of the feed slide in moving the clip into the gun, the stop pawl slides into a slot in the upper edge of the feed slide and prevents the slide from moving the clip farther than necessary to have a round removed. The holding pawl engages a slot in the clip and prevents

the clip from being moved back as the feed slide moves back in preparation for another round. Figure 9 shows how these parts function.

(7) *Stripper cam* (fig. 2).—This cam is screwed to the right upper part of the trunnion block and lies below the path of the incoming ammunition clip. As the clip moves in, the cam forces the cartridge out of the clip and down into the gun mechanism. Figure 10 shows the ammunition clip and cartridge moving toward the stripper cam and figure 11 shows the cartridge being forced down and out of the clip.

(8) *Carrier assembly and carrier catch*.—The carrier is a long flat lever which pivots vertically about an axis in the back part of the feed box. The carrier dog is a short flat edged piece that pivots about the lower back part of the carrier and is positioned by a spring and plunger located in the carrier body (fig. 18). During recoil, the lock frame presses the carrier dog up against the spring and plunger and then the dog holds the lock frame in the recoiled position. In this position the compressed carrier spring causes the carrier to exert a downward force on the carrier catch (fig. 12). The carrier catch is so positioned that it holds the carrier in a horizontal plane just above the incoming cartridges. As the cartridge is stripped from the clip, it pushes the carrier catch against a spring and plunger (fig. 13), thus-freeing the carrier to push the cartridge down into the gun mechanism. When the carrier reaches its lowest limit, it kicks the dog out of the notch in the lock frame and the lock frame then charges the cartridge into the firing chamber. The carrier is brought up over the carrier catch by the recoiling tube extension (par. 9c).

(9) *Cartridge feeder pawl handle*.—This is the small knob that protrudes through the front plate of the feed box. Under normal operating conditions the gun mechanisms can only move the ammunition clip from left to right. If it is necessary to withdraw the clip after it has started to enter the mechanism, the button on the feed pawl must be lifted and the cartridge feeder pawl handle pulled forward before the clip can be removed.

**9. Tube and tube extension** (figs. 14 and 15).—The gun tube is threaded into and locked to the front of the tube extension. The entire assembly recoils  $10\frac{3}{4}$  inches in the trunnion block. The tube extension consists of the front portion, which contains the tube receptacle, tube lock, recuperator piston rod receptacle, driving spring front bracket, breechblock plunger, and the breechblock stop. The tube lock is a snap lock which engages the gun tube and prevents it from turning loose in operation. A vertical opening directly in back of the tube socket acts as the guide for the breechblock as the latter moves up and down during the operation of the gun. The breechblock plunger

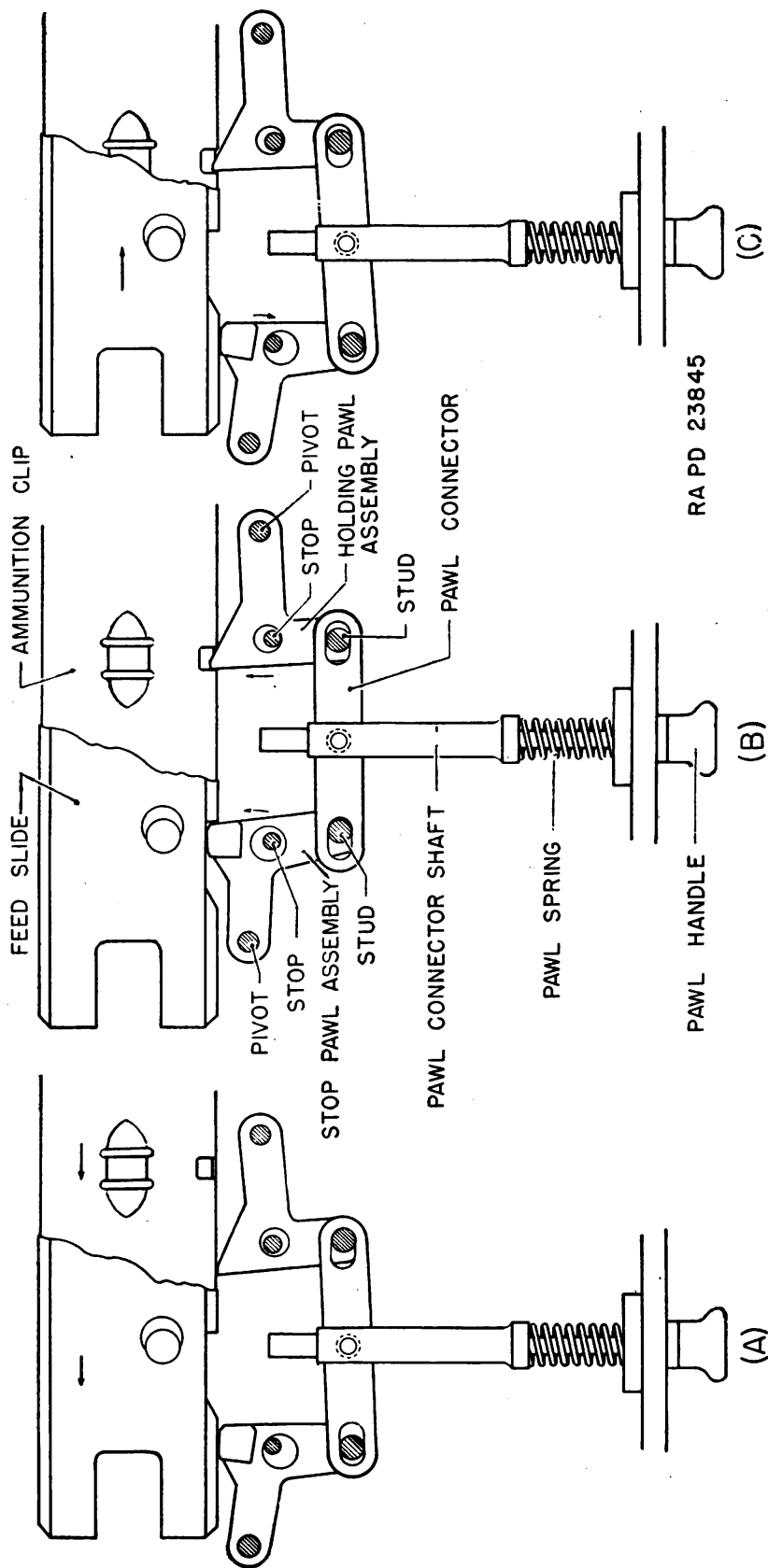


FIGURE 9.—Function of stop pawl and holding pawl assemblies.

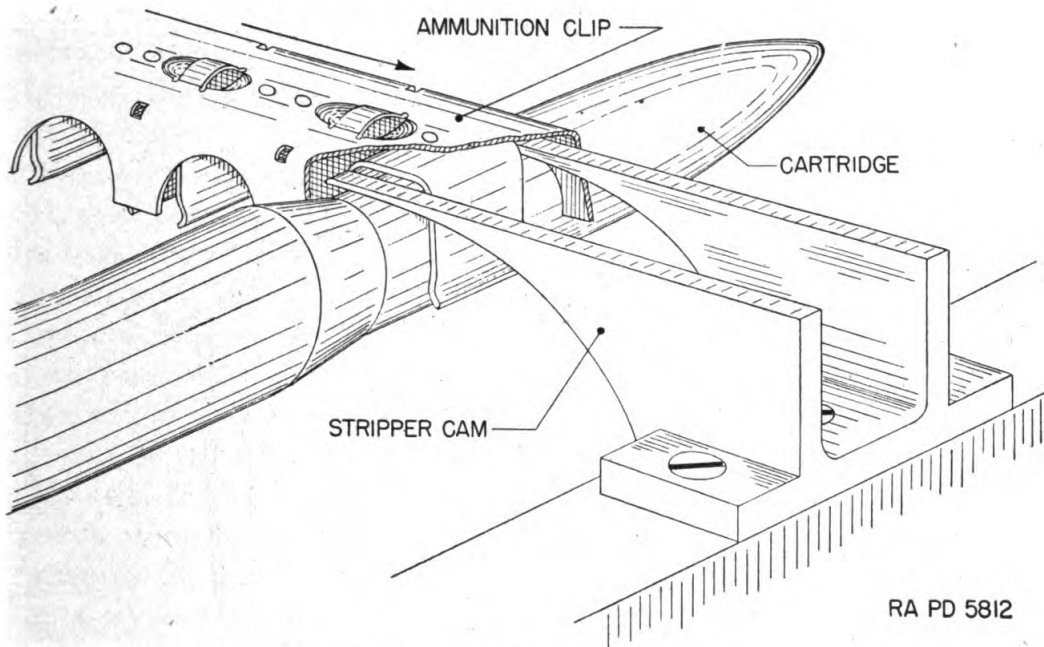


FIGURE 10.—Start of stripper cam action.

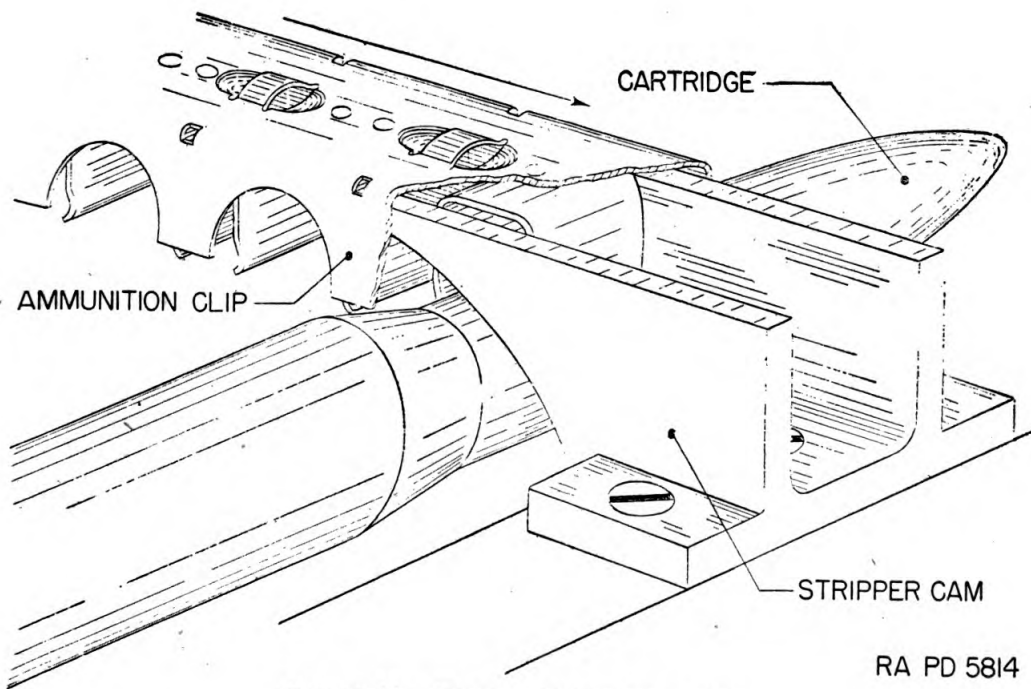


FIGURE 11.—End of stripper cam action.



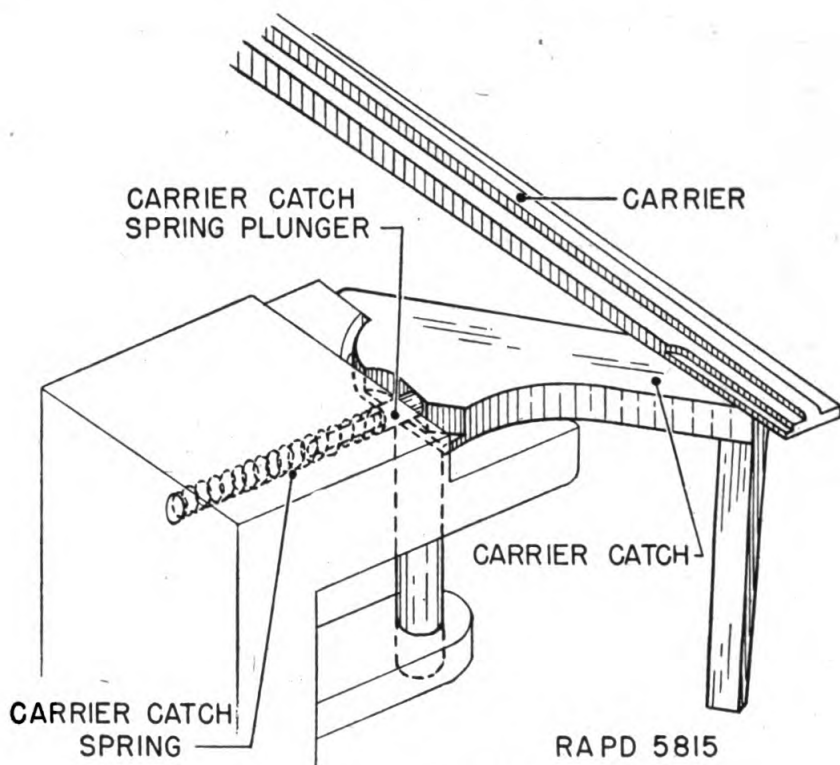


FIGURE 12.—Carrier supported by carrier catch.

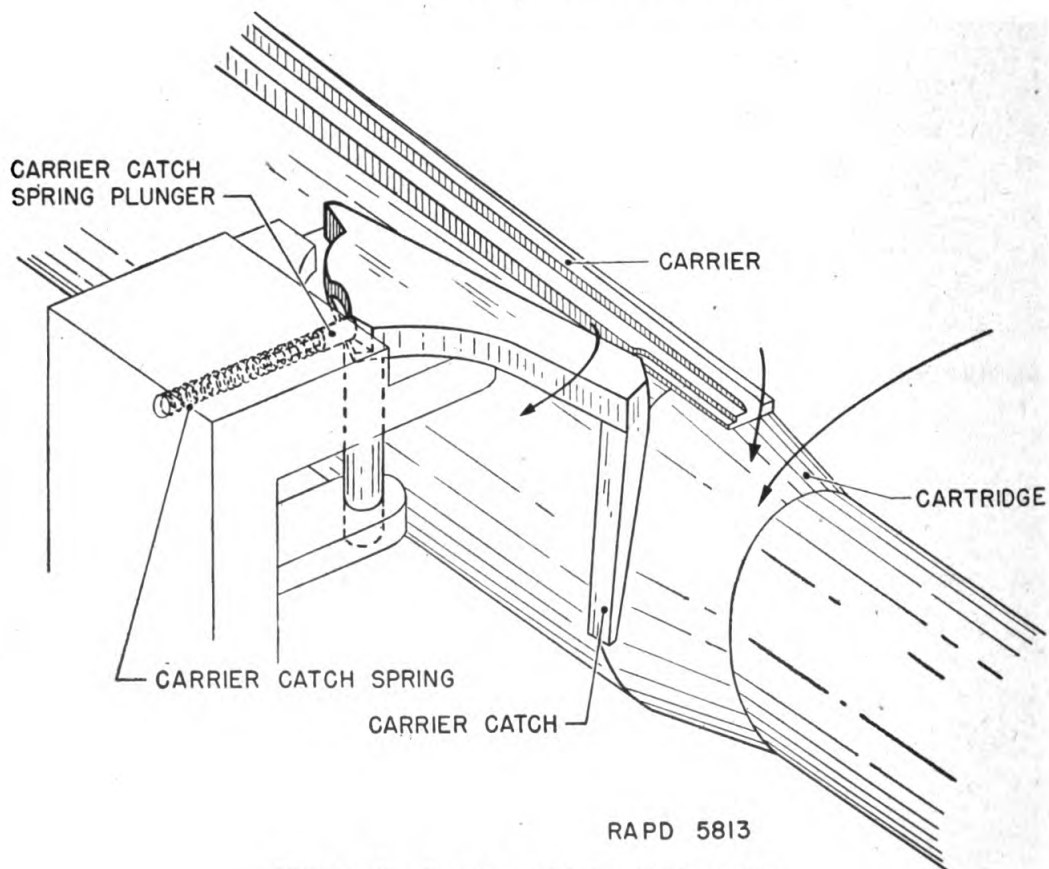


FIGURE 13.—Carrier pushing cartridge down.

steadies the motion of the breechblock in its slideways. Two vertical side plates extend rearward on the tube extension. These plates act as the receptacle for the incoming cartridge and also contain the accelerator, trigger levers, carrier cam, ejector, and the feed lever operating stud, the functions of which are as follows:

*a. Accelerator assembly (fig. 15).*—This is a lever which, when revolved about its axis by a cam (fig. 19) on the lower rear part of the left side plate of the trunnion block, accelerates the lock frame to the back plate buffer mechanism.

*b. Trigger lever assembly.*—Figure 17 shows all parts of the firing mechanism removed from the gun and in their proper relationship to each other. The trigger lever assembly is located on the right side plate of the tube extension (fig. 14), and the trigger trip is located on the top of the same part. The sear (fig. 16), however, and cocking lever (fig. 18) are found on the lock frame. The trigger bar lies in a groove along the bottom of the right side plate of the feed box and transmits the motion of the trigger (fig. 2) to the trigger levers.

*c. Carrier cam (fig. 14).*—This is a long narrow cam fixed to the top of the right side plate of the tube extension. During recoil the carrier cam raises the carrier so that it is caught by the carrier catch.

*d. Ejector.*—The ejector rotates about a pin on the inside of the left side plate of the tube extension. As the cartridge case is extracted from the firing chamber, a cam located in the trunnion block operates the ejector so that the ejector pushes the case out of the mechanism through the bottom of the trunnion block.

*e. Feed lever operating stud (fig. 14).*—As the tube extension recoils, this stud, projecting from the right side plate of the tube extension, passes to the rear of the feed lever. On counterrecoil the stud pushes the feed lever forward, thus actuating the entire feed mechanism and feeding a new round into the tube extension.

**10. Lock frame assembly (fig. 16).**—The lock frame is a separate recoiling unit that fits between the side plates of the tube extension. These two units recoil together until the lock frame is struck by the accelerator. The lock frame then continues recoiling until it strikes the back plate buffer while the tube extension comes to the end of its recoil. At the time of acceleration of the lock frame, the extractor, located on the front of the lock frame, draws the cartridge case from the firing chamber. The lock frame, during counterrecoil, pushes the cartridge into the firing chamber and also causes the breechblock to rise in its slot. The operating lever is pivoted to the lower part of the lock frame and rides in cam grooves secured to the lower surfaces of the trunnion block side plates. The motion of the operating lever

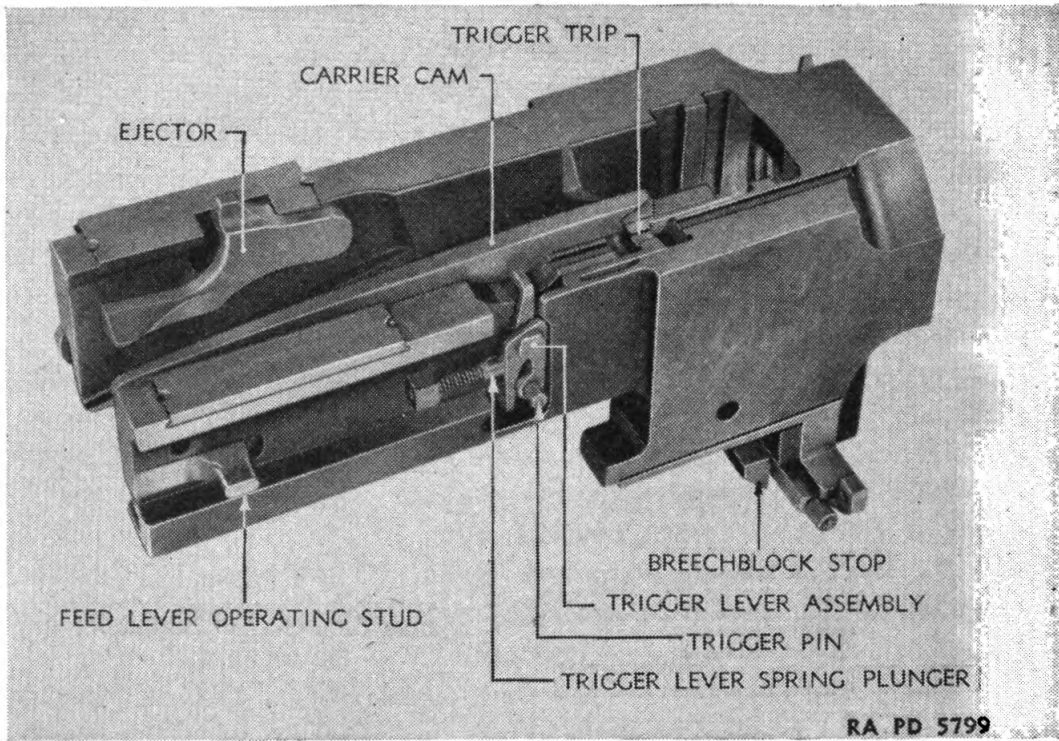


FIGURE 14.—Right rear view of tube extension.

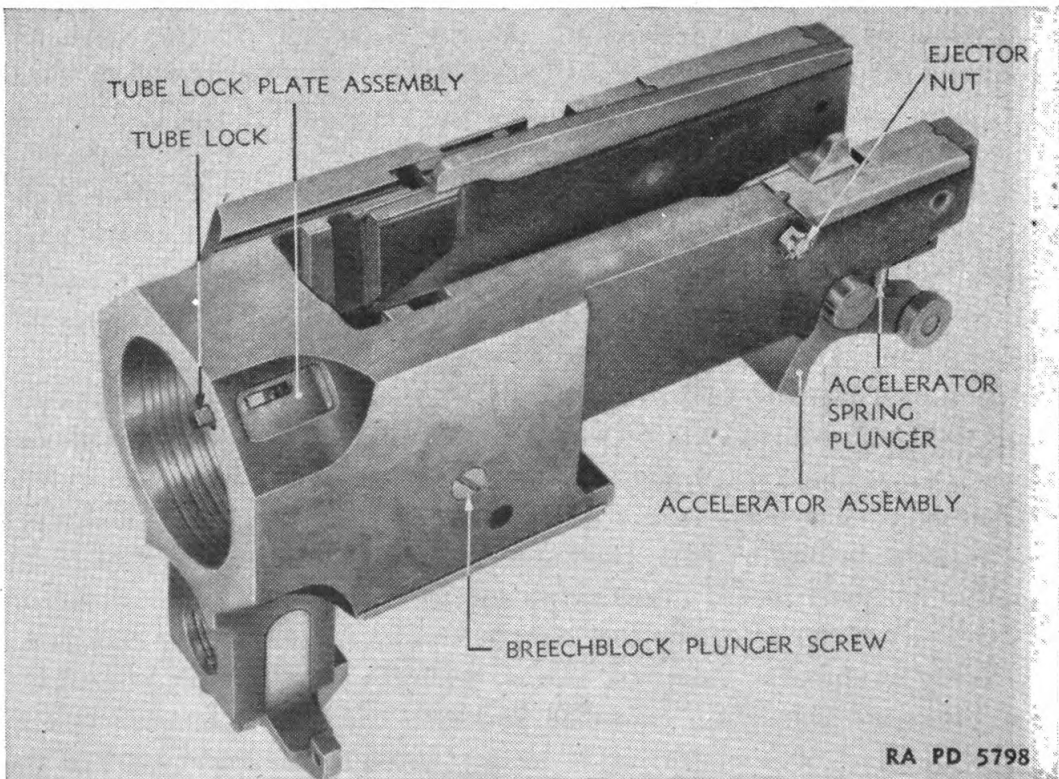


FIGURE 15.—Left front view of tube extension.



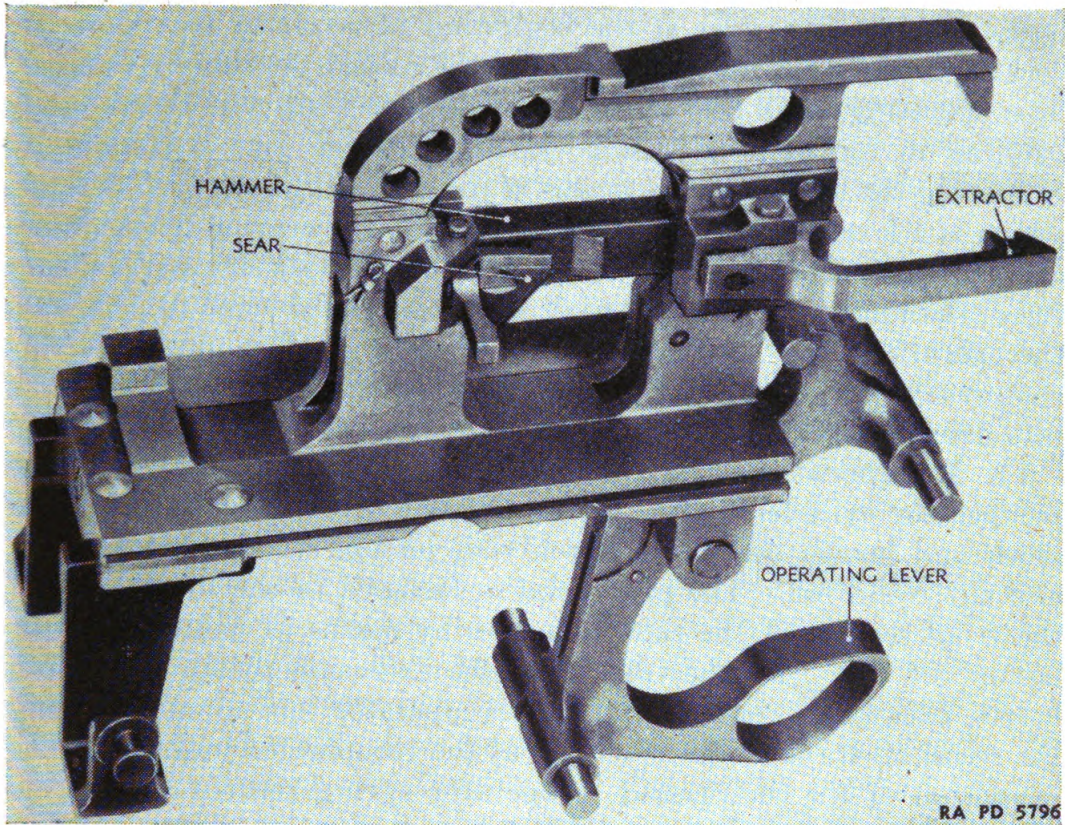


FIGURE 16.—Lock frame assembly.

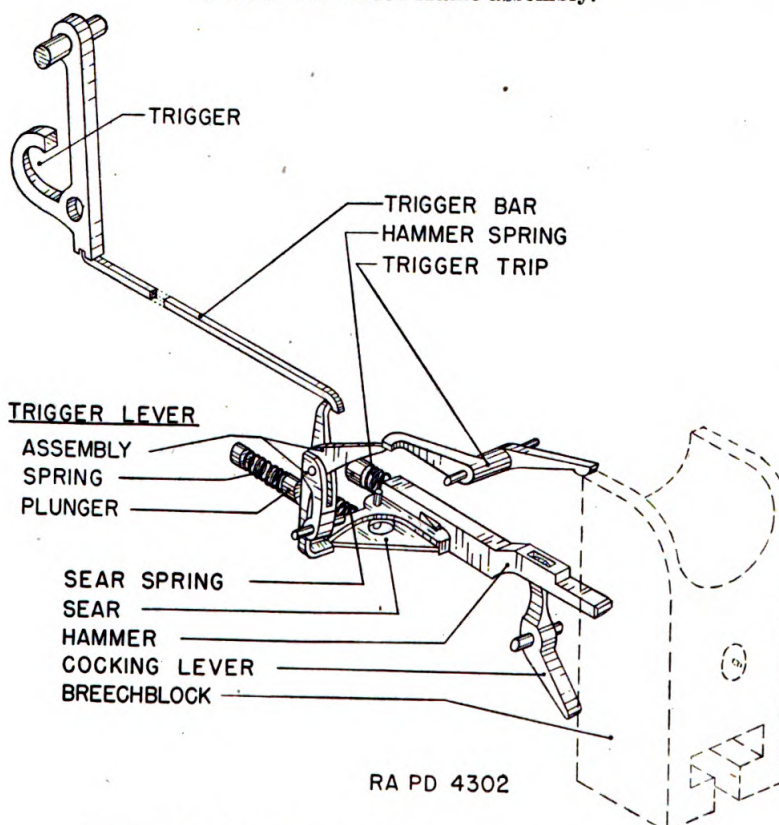


FIGURE 17.—Elements of firing mechanism in position.

cocks the firing hammer at the beginning of recoil by means of the cocking lever. The hammer is held in the cocked position by the sear. The operating lever also moves the breechblock up and down in its opening in the tube extension. Loading of the gun is started by retracting the lock frame by means of the operating lever. The strut, which is a lever that pivots about a pin in the operating lever, enters an opening in the under center portion of the lock frame. During recoil the motion of the operating lever causes the strut to compress the operating lever spring (fig. 3). At the end of counterrecoil this compressed spring causes the operating lever to lift the breechblock into firing position.

**11. Recuperator** (figs. 1 and 2).—*a. Recuperator cylinder.*—The recuperator cylinder fits in the lower front opening of the trunnion block and houses the recoil piston rod, piston, recuperator springs, and the recoil oil. The piston rod is fastened to the lower part of the front section of the tube extension by means of the recuperator piston rod nut. As the tube and tube extension recoil, the piston moves backward, compressing the recuperator spring and forcing the recoil oil through the openings of the recuperator bushing. The expansion of the compressed recuperator spring returns the piston, piston rod, and recoil oil to their initial positions, thereby causing counterrecoil. The tube and tube extension are carried back to battery by the recuperator piston rod.

*b. Expansion tube* (fig. 1).—This is the small cylinder screwed to the upper front end of the recuperator. This cylinder is a hollow body used to compensate for expansion and contraction of the recoil oil in the recuperator.

**12. Driving spring assemblies.**—*a. Description* (fig. 2).—These are two spring assemblies running lengthwise outside the lower right- and left-hand sides of the gun assembly. These springs are used to drive the lock frame back to firing position after recoil. Each assembly consists of a long narrow tube, a piston rod, piston, and two springs. A small bracket, secured to the outside of the tube near its rear end, is connected to the bracket located on the lower front part of the tube extension. The end of the piston rod extends out of the rear of the driving spring assembly and terminates in a hook that connects to the lower rear projecting stud of the lock frame. Thus the driving spring tube is connected to the tube extension and the driving spring piston rod is connected to the lock frame.

*b. Function.*—As recoil starts, the tube, tube extension, and lock frame recoil together, carrying with them the driving spring assemblies. The tube and tube extension start to counterrecoil shortly



after the lock frame is accelerated rearward. The tube of each spring assembly moves forward with the tube extension while the piston rod and piston move rearward with the lock frame, thus compressing the driving springs. Then, at the proper moment, these compressed springs act on the piston to bring the lock frame back to firing position.

**13. Back plate assembly (fig. 2).**—The back plate of the gun assembly contains the gun buffer mechanism. This consists of two springs, two buffer pieces, and a buffer plunger. One spring is located inside the other and all the parts are assembled in a small vertical cylinder forged to the back plate. The shock of the recoiling lock frame is taken up by the buffer plunger and transmitted to the springs by the two buffer pieces. The buffer mechanism is adjusted by means of the screw located at the top of the cylinder.

**14. Functioning of gun.—a. General.**—The series of operations and motions of the various parts of the gun occur in a definite and interrelated manner. Each part receives its motion from some other part, and each functions in a very definite and specific moment of the entire cycle, of which there may be as many as 120 a minute. To describe the actions and functions of the various parts of the gun during one complete cycle, the entire operation will be broken down into the following motions and each will be discussed in detail, giving the events as they normally occur.

(1) Recoil.

(2) Counterrecoil of the tube and tube extension.

(3) Counterrecoil of the lock frame.

**b. Recoil (figs. 18, 19, and 20).**—(1) Immediately after the detonation, the tube, tube extension, and lock frame start to recoil together. The carrier cam on top of the tube extension engages the projecting stud of the carrier, which is then pushed up by the cam. The carrier rises until caught in its uppermost position by the carrier catch. As the lock frame recoils, the operating lever starts to revolve due to the action of the operating cams below the right and left side plates of the trunnion block. The operating lever, which is engaged to the breechblock, pulls the latter down until the breechblock rests on its stop at the bottom of the tube extension. Coincident with this motion is that of the cocking of the firing hammer. This is accomplished when a projection of the operating lever forces one end of the cocking lever forward, causing the other end to move the firing hammer rearward until caught by the sear. The rotation of the operating lever also forces the strut back against the action of the follower and spring located in the base of the lock frame.

## KEY TO ABBREVIATIONS IN FIGURES 18-22

TE—Tube extension

B—Breechblock

T—Tube

A—Accelerator

FL—Feed lever

C—Carrier

CD—Carrier dog

TL—Trigger levers

AC—Accelerator cam

OL—Operating lever

CC—Carrier catch

BP—Buffer plunger

Sw—Switch

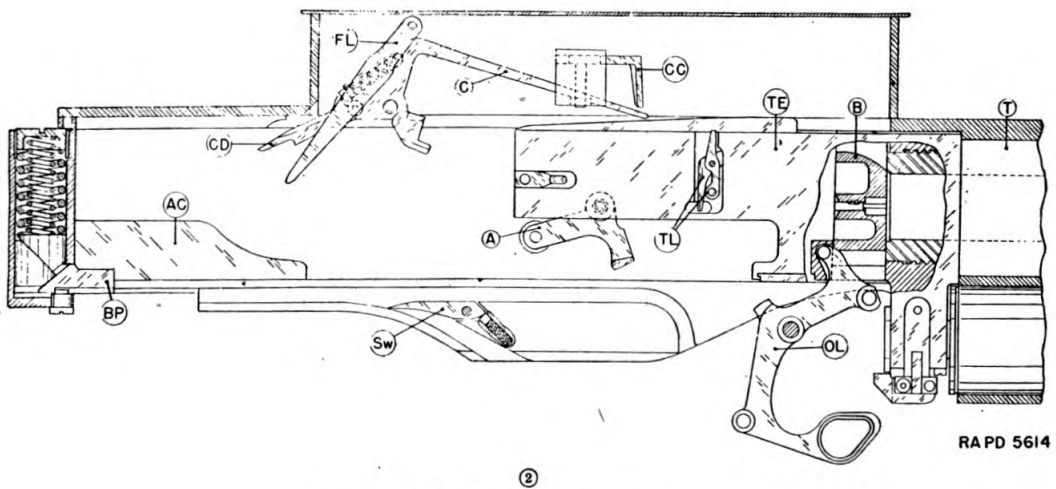
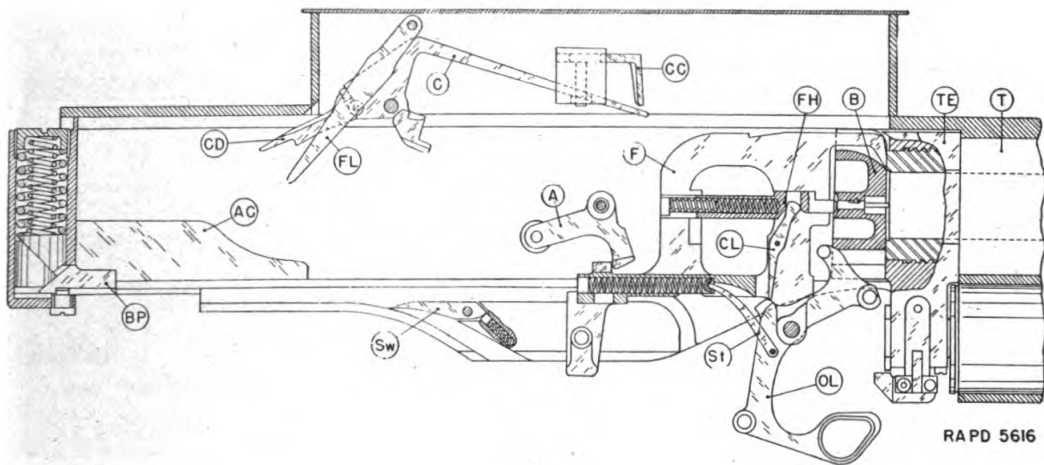
F—Lock frame

CL—Cocking lever

St—Strut

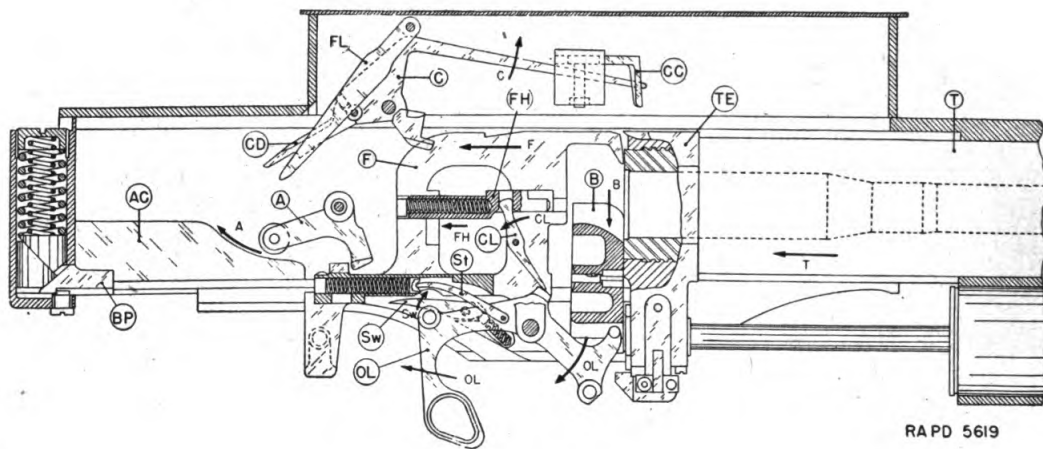
FH—Firing hammer

NOTE.—Arrows designate the direction of motion and the small letters alongside the arrows name the part to which the arrows belong.

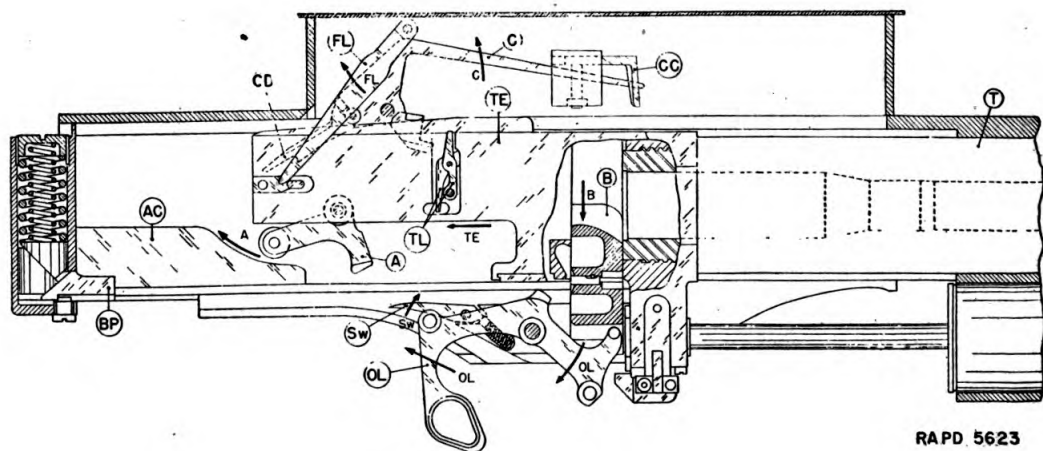


TE and F in battery position.  
B raised and covering firing chamber.  
OL supports B.  
C in low position.  
FL points toward the rear.  
FH in forward position.

FIGURE 18.—Battery position with trigger pulled.



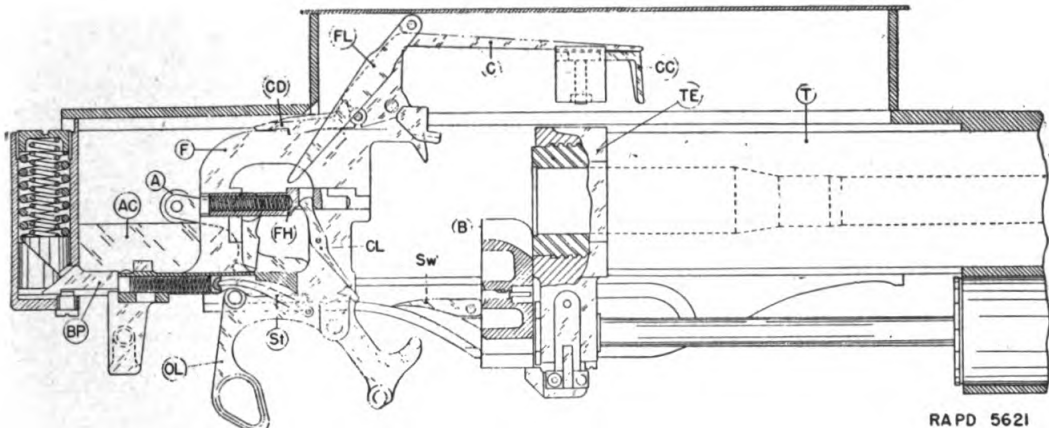
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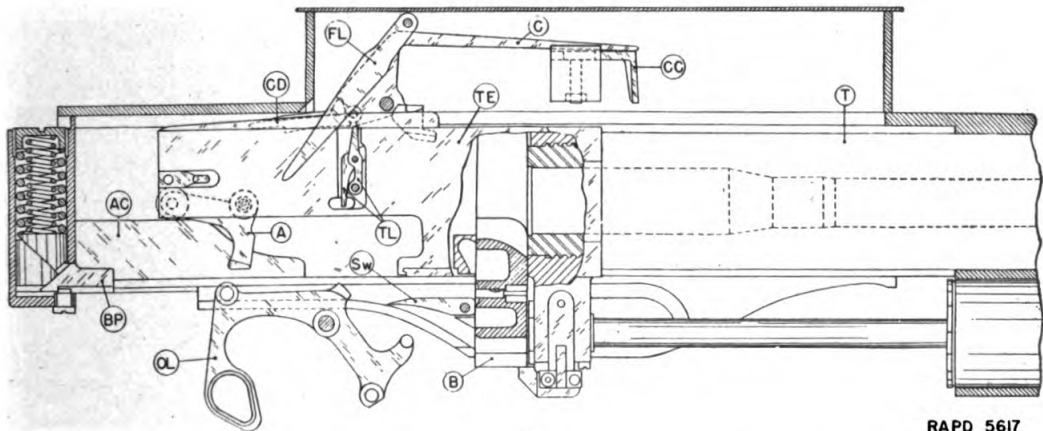
T, TE and F recoil together.  
 OL rotates about its pivot.  
 B pulled down by OL.  
 OL forces Sw open.  
 OL rotates CL which cocks FH.  
 St pushed rearward.  
 A starts to roll on AC.  
 C raised by cam on TE.  
 Feed lever stud of TE forces FL to rear and passes under it.

FIGURE 19.—Partial recoil.



RAPD 5621

①



RAPD 5617

②

F raises CD, hits BP, rebounds, and is caught by CD.

TE starts counterrecoil.

B on breechblock rest.

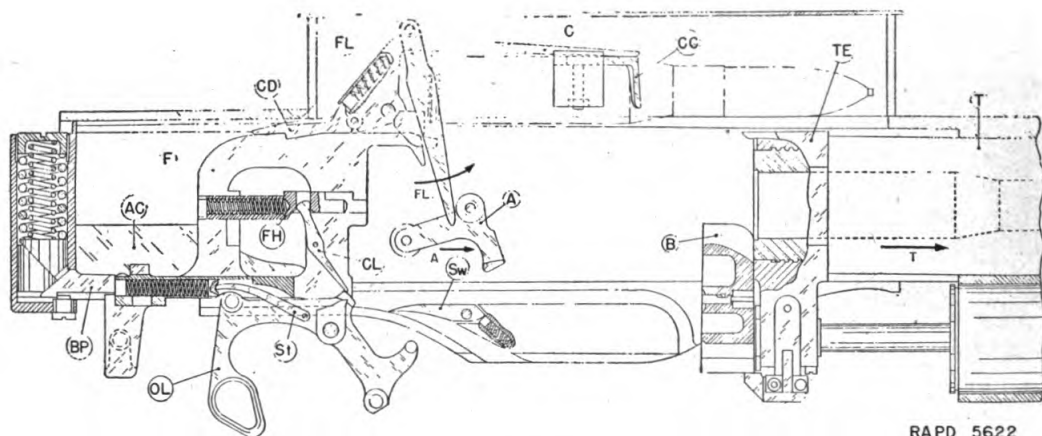
A accelerates F and rolls to top of AC.

Feed lever stud of TE behind FL.

C rests upon CC.

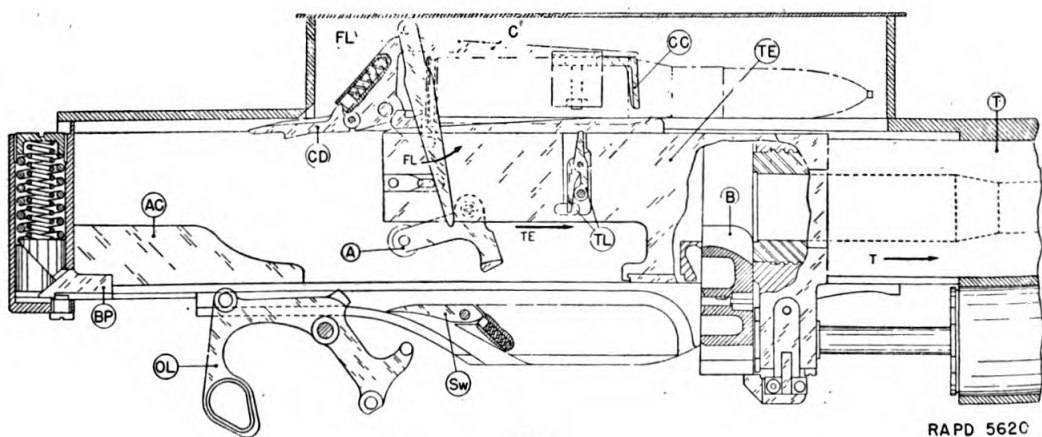
Carrier spring compressed.

FIGURE 20.—Full recoil position.



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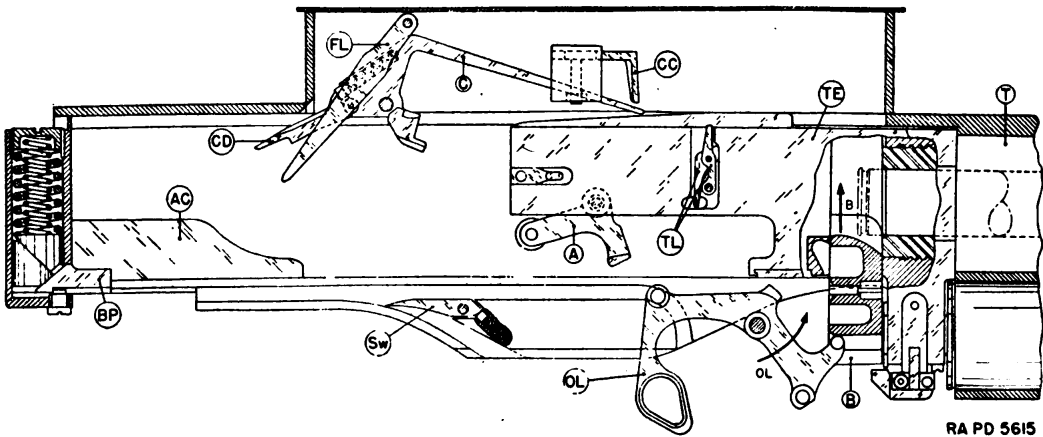
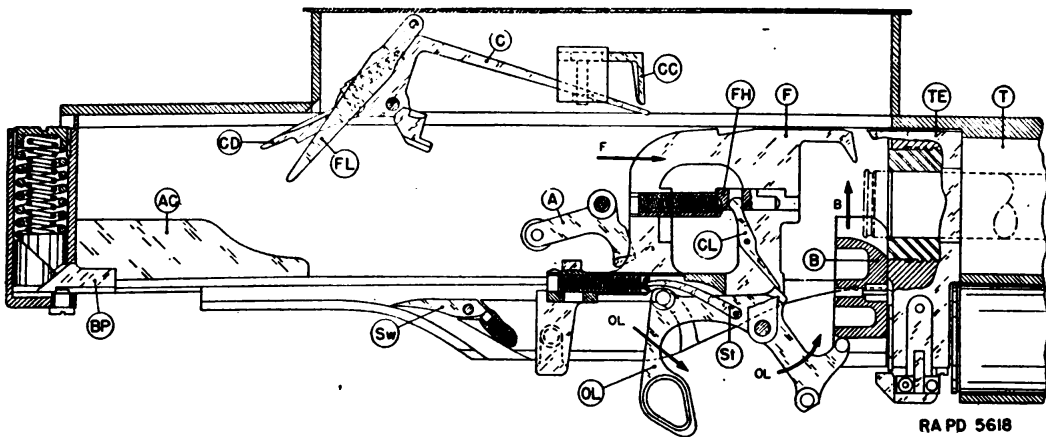
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F still secured by CD.  
 Partial counterrecoil of TE.  
 Feed lever stud of TE swings FL forward.  
 Cartridge appears in feed box.  
 Cartridge disengages CC from C.  
 B remains on breechblock rest.

FIGURE 21.—Partial counterrecoil.





②

T and TE in battery position.  
 F moving forward and almost in battery position.  
 CD forced down by carrier spring.  
 OL follows upper cam.  
 OL starts to push B up.  
 St starts to act on OL.  
 Cartridge is forced into firing chamber.  
 C is completely lowered.  
 FL has been forced to rear position.

FIGURE 22.—End of counterrecoil.

(2) Toward the end of the recoil (fig. 19) of the tube and tube extension, the accelerator starts to ride up on the accelerator cam. The motion given the accelerator by its cam causes the accelerator to kick the lock frame to the back plate buffer plunger. The tube and tube extension come to the end of recoil and the recuperator spring will immediately draw them back to firing position.

*c. Counterrecoil of the tube and tube extension (figs. 21 and 22).—*The extractor located at the front center position of the lock frame curves around the breechblock and is hooked into the extractor groove of the cartridge case. The extractor remains in this position from the moment of charging the round into the firing chamber until ejection of the empty cartridge case. As the tube extension counterrecoils and the lock frame accelerates rearward, the cartridge case is withdrawn from the chamber by the extractor. A cam then rotates the ejector, which deflects the empty case down through the opening of the trunnion block. As this is taking place, the driving spring piston rod is carried rearward by the lock frame and the driving spring tube carried forward by the tube extension. This causes the driving springs to be compressed. On counterrecoil, the feed lever operating stud pushes the feed lever forward, causing this lever to actuate the system of levers and links that carries the next cartridge into the feed box, strips the round from the clip, and feeds the round into the tube extension. The feed lever is then forced back to its initial position by the action of the feed slide return lever, located in the front of the feed box.

*d. Counterrecoil of the lock frame (figs. 21 and 22).—*When the lock frame strikes the back plate, the back plate buffer springs take up the shock by means of the buffer friction pieces and the buffer plunger. The lock frame then rebounds about  $\frac{1}{2}$  inch and is caught by the carrier dog pressing into the notch in the upper surface of the lock frame. At this time the tube extension is almost entirely in battery position and the feed mechanism has fed a new cartridge into the feed box. As the round enters the feed box, it is stripped from the clip and then disengages the carrier catch. The cartridge then tips down into the tube extension. The carrier pushes the round down and finally trips the carrier dog out of the notch in the lock frame. The lock frame, released from the carrier dog, springs forward under the compression of the driving springs and rams the cartridge into the firing chamber. As the lock frame moves forward the extractor engages the extractor groove of the shell and the operating lever follows the upper operating camway. Near the end of the operating lever motion a projecting pin on the operating lever engages the breechblock and, with the help of the operating lever spring and the strut, the breechblock is

forced up in its groove in the tube extension. As the breechblock reaches its final position, it hits the trigger trip located on top of the tube extension.

*e. Action of the firing mechanism (fig. 17).*—Two separate motions are required to cause the firing hammer to be released and shoot the gun. The trigger pulls the trigger bar, which in turn pulls back the top of the trigger lever assembly. The second motion is that of the breechblock rising and hitting the front end of the trigger trip. This latter part then transmits its motion to the front top portion of the trigger lever assembly. These two motions given the trigger lever assembly cause the assembly to move back sufficiently to disengage the sear from the firing hammer. The hammer can then spring forward and strike the firing pin in the breechblock.

**15. Description of caliber .50 machine gun.**—*a. General.*—The Browning machine gun, caliber .50, M2, water-cooled, is a recoil operated, belt fed, water-cooled machine gun. The metallic link, disintegrating belt is used in all firing of the gun.

*b. Cooling system.*—The cooling system for the water-cooled machine gun consists of a water jacket surrounding the barrel and a water chest with pump. The water jacket of the 45-inch barrel contains 10 quarts of water. The water chest contains approximately 8 gallons of water. Both the water jacket and the water chest should be kept full at all times. In an emergency the full water jacket of the gun will permit cooling for short duration. However, for prolonged fire the water chest should always be coupled to the gun, and the entire circulating system kept full of water. The water absorbs the heat generated in firing the gun and thus prevents the barrel from becoming overheated. The steam tube is located in the top of the water jacket and is free to slide on the front and rear steam tube supports. Each of these supports is provided with a hole, the rear one being covered by the steam tube when the gun is elevated and the front one when the gun is depressed, thus preventing the escape of water from the jacket. The opposite hole, which is uncovered by this movement, allows the water and any steam generated through prolonged firing to escape through the steam tube and the outlet leading to the water supply or the circulating unit where any steam is condensed.

*c. Feeding.*—By properly repositioning some of the component parts, the gun may be fed from either the right- or left-hand feed. A retracting slide is provided which is connected with the bolt by means of the retracting slide bolt stud. The retracting slide handle remains stationary and in a forward position while the gun is firing, thus eliminating all moving parts outside of the receiver.

*d. Sights.*—The gun is equipped with the conventional machine-gun front and rear sights.

(1) *Front sight.*—The front sight is the conventional blade type and is protected by the front sight cover.

(2) *Combination rear sight.*—The combination rear sight is the conventional leaf type sight. The sight is adjustable for windage. The drift is offset automatically by the construction of the rear sight leaf. The wind gage arc on the base is graduated in mils. The leaf is graduated in yards up to 3,200 yards for caliber .50, M1 ammunition with a muzzle velocity of 2,400 feet per second. New leaf, now under manufacture, will be graduated for ammunition of 2,600 feet per second muzzle velocity. Calibration of the sight leaf for ammunition of different muzzle velocities may be obtained by the use of the elevating screw which raises or lowers the slide 1 mil. By pressing in the half nut, instantaneous adjustment of the slide can be accomplished.

*e. Recoil mechanism.*—An oil buffer mechanism in the gun cushions the force of the recoiling part.

**16. Functioning of caliber .50 machine gun.**—Functioning is that operation which is automatically performed by the gun itself when fired. The following explanation of functioning begins with the gun assumed to be loaded and ready to fire.

*a. Side plate trigger action on first shot.*—When the side plate trigger slide is pulled to the rear, the action of the side plate trigger cam forces the sear slide inward. This in turn forces the sear downward, releasing the sear notch from the shoulder of the firing pin. The firing pin spring forces the firing pin forward to fire the cartridge.

*b. Backward movement of recoiling parts.*—The explosion of the cartridge forces the barrel to the rear, carrying with it the barrel extension and the bolt which is locked to the barrel extension by the breech lock. When the barrel has recoiled about  $\frac{3}{4}$  inch, the breech lock pin strikes the cam surfaces of the breech lock depressors. This unlocks the bolt from the barrel extension and permits the bolt to continue to the rear. As the barrel extension moves to the rear it strikes the accelerator and turns it backward.

*c. Backward action of accelerator.*—As the accelerator turns backward it strikes the bottom projection on the bolt and accelerates it to the rear. The shoulders on the barrel extension shank engage behind the claws of the accelerator, locking the barrel and barrel extension in a rearmost position to the oil buffer body.

*d. Backward movement of bolt.*—As the bolt moves backward the driving spring is compressed. The bolt brings with it a cartridge from the belt gripped by the extractor and an empty case from the

chamber gripped in the T-slot. The cam lug on the extractor rides along on top of the switch until near the end of the backward movement of the bolt. Then the extractor by action of the cover extractor cam is forced downward until its cam lug is below the switch.

*e. Action of oil buffer.*—As the barrel and barrel extension move backward together, the oil buffer spring is compressed, since the oil buffer piston rod is linked directly with the barrel extension by means of the hook on the shank projecting from the rear of the barrel extension and the hook on the forward end of the oil buffer piston rod; the oil buffer piston rod head and the oil buffer piston valve are driven rearward in the oil buffer tube forcing the oil through the restricted openings in both the piston rod head and valve. This supplements the action of the oil buffer spring in bringing the heavy recoiling parts to rest without damaging shock or strain on the gun. On the counter-recoil or forward movement of the barrel and barrel extension, the oil in front of the piston rod head will force back the piston valve, uncovering the openings and permitting the oil to pass readily from the forward to the rear side of the piston rod head and valve, thus permitting the rapid return of the parts to the firing position.

*f. First action of feeding.*—As the bolt moves backward, the stud on the belt feed lever riding in its cam groove in the top of the bolt moves the belt feed pawl laterally into position behind the next cartridge. The ammunition belt is prevented from falling out of the gun by the belt holding pawl.

*g. Cocking action.*—As the bolt moves backward, the upper end of the cocking lever is forced forward by the top plate bracket attached to the top plate, which brings the lower end of the cocking lever to the rear. When the lower end of the cocking lever moves to the rear it brings with it the firing pin, withdrawing the firing pin from the face of the bolt and compressing the firing pin spring against the sear stop pin. The shoulder of the firing pin engages in the notch in the sear under pressure of the sear spring.

*h. Action of driving spring.*—When the rear end of the bolt strikes the buffer plate, its remaining force is absorbed in the fiber buffer disks. The driving spring which has been compressed by the backward action of the bolt then forces the bolt forward. On guns manufactured after June 1940, two driving springs, one inside the other and wound in opposite directions, are used. By the use of two springs, greater initial spring load is provided which is an advantage in feeding ammunition during high angles of fire. The new assembly will be available for replacement of old type assemblies now in service.



*i. Forward movement of bolt.*—When the bolt starts forward the cam lug on the extractor riding under the switch rotates the extractor downward. This causes the extractor to force the cartridge down the T-slot in line with the chamber. The ejector knocks the empty case from the T-slot and holds the cartridge in line with the chamber. (The empty case may have already fallen out without the action of the ejector.) The upper end of the cocking lever is forced backward and the lower end moves forward away from the rear of the firing pin.

*j. Release of recoiling parts.*—The lug on the lower end of the bolt strikes the accelerator and rotates it forward. This unlocks the barrel extension from the oil buffer body. The barrel extension remains linked with the oil buffer piston rod. (See *e* above.) When the accelerator has been tripped the barrel extension and the barrel move forward, assisted by the oil buffer spring. Part of the forward force of the bolt acts through the accelerator to push the barrel extension forward.

*k. Loading and locking action.*—The extractor rises as its cam lug moves along the top of the extractor cam and the ejector moves outward, leaving the cartridge in the chamber engaged by the T-slot. The extractor grips the first round in the belt and is held down firmly, ready to extract it, by the cover extractor spring. The breech lock is forced upward by the breech lock cam and locks the breech just before the recoiling parts reach the firing position. (The breech lock engages in a recess cut in the bottom of the bolt and thus locks it firmly to the barrel extension and against the rear end of the barrel.)

*l. Second action of feeding.*—As the bolt goes forward, the stud on the end of the belt feed lever riding in its cam groove in the top of the bolt moves the belt feed slide and belt feed pawl in a lateral direction. The belt feed pawl carries the first cartridge against the cartridge stops, ready to be gripped by the extractor. The next cartridge is carried over the belt holding pawl, which rises behind it and holds it in position to be engaged by the belt feed pawl on its return movement.

*m. Automatic fire.*—As long as the foot treadle is depressed, and the ammunition holds out, the gun will fire automatically.

## SECTION III

## DESCRIPTION AND FUNCTIONING OF GUN CARRIAGE

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**17. General.**—*a.* The 37-mm automatic gun M1A2 is mounted on an M3, M3E1, or M3A1 carriage (figs. 23 to 28). At the present time the M3A1 carriage is a standard model, M3 substitute standard, and M3E1 is classified as limited procurement type. These carriages are of the two-axle, four-wheel trailer type and are equipped with pneumatic tires and electric brakes on all wheels. There is a manually operated brake on each of the rear wheels. A drawbar and lunette connect the carriage to the prime mover.

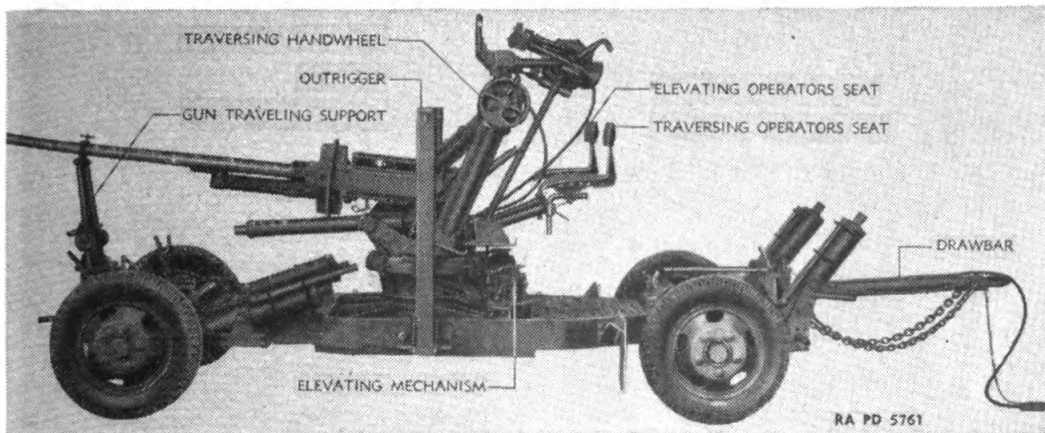


FIGURE 23.—37-mm AA gun carriage in traveling position.

*b.* The carriage consists mainly of the chassis and the top carriage. The chassis supports the top carriage and contains all mechanisms necessary for maneuvering and emplacing the carriage. The top carriage is the rotating part, and contains all mechanisms necessary for laying, setting, and firing the gun.



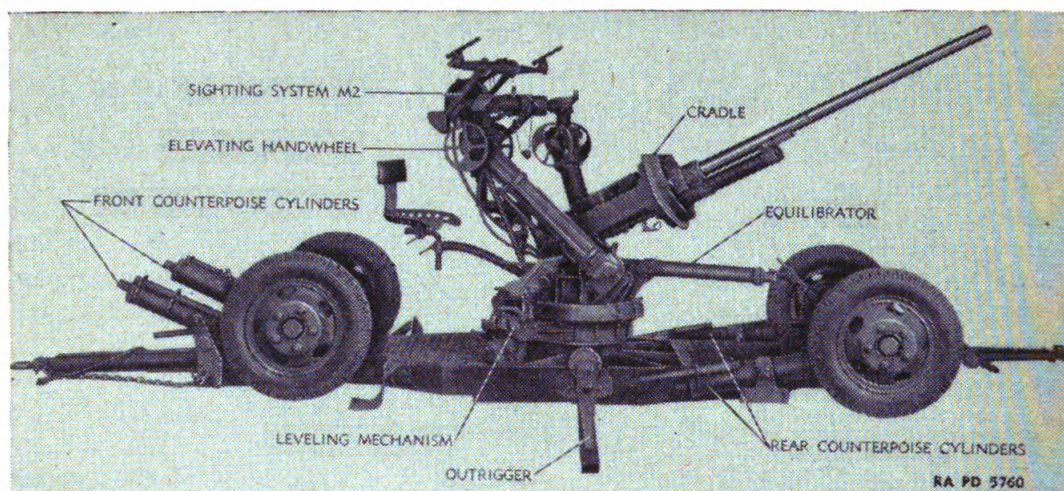


FIGURE 24.—37-mm AA gun carriage M3 in firing position.

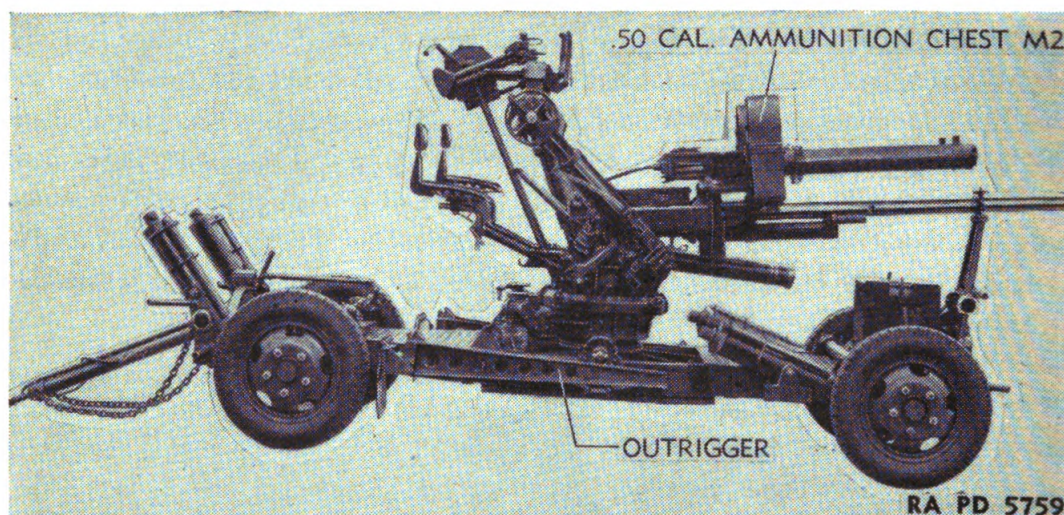


FIGURE 25.—37-mm AA gun carriage M3E1 in traveling position.

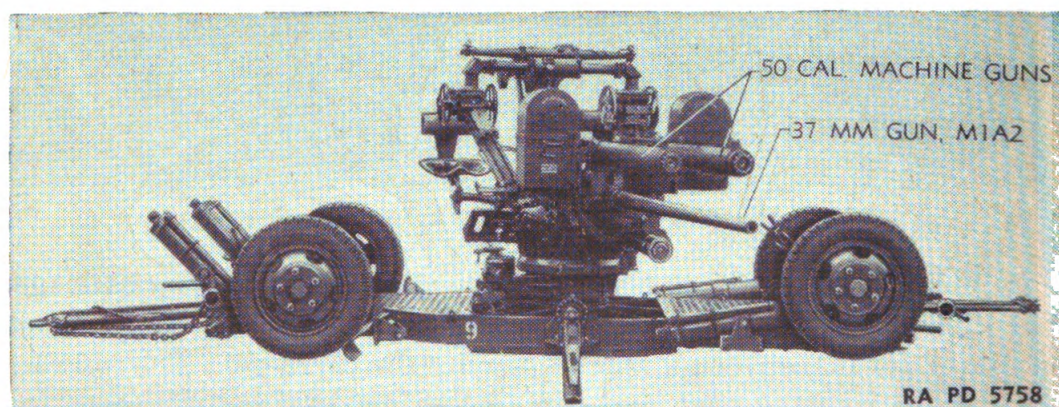


FIGURE 26.—37-mm AA gun carriage M3E1 in firing position (telescopes removed from sighting system).



c. The main assemblies on these carriages are—

- (1) Chassis.
- (2) Counterpoise cylinders.
- (3) Buffer mechanism.
- (4) Brakes.
- (5) Leveling mechanism.

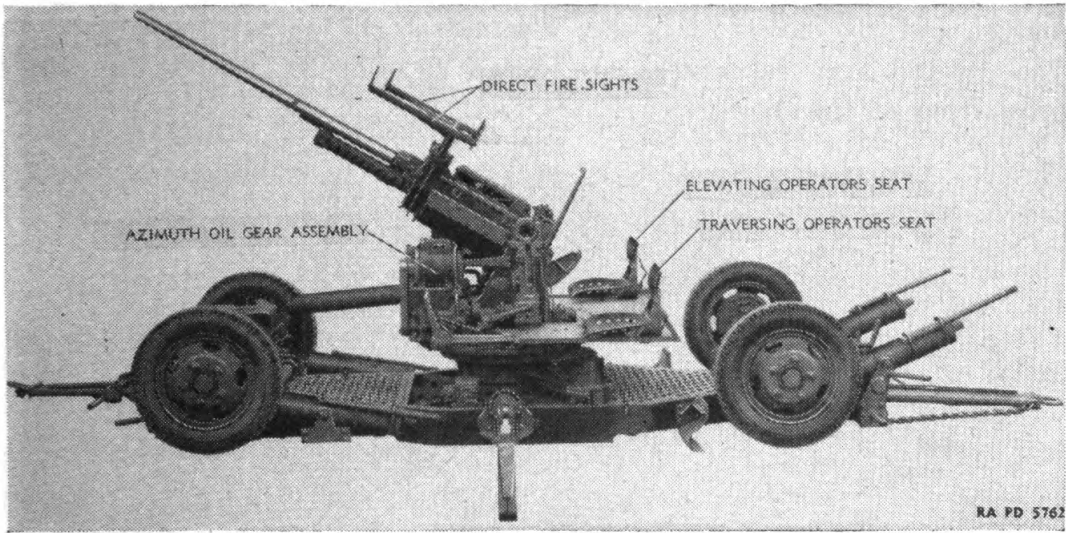


FIGURE 27.—37-mm AA gun carriage in firing position.

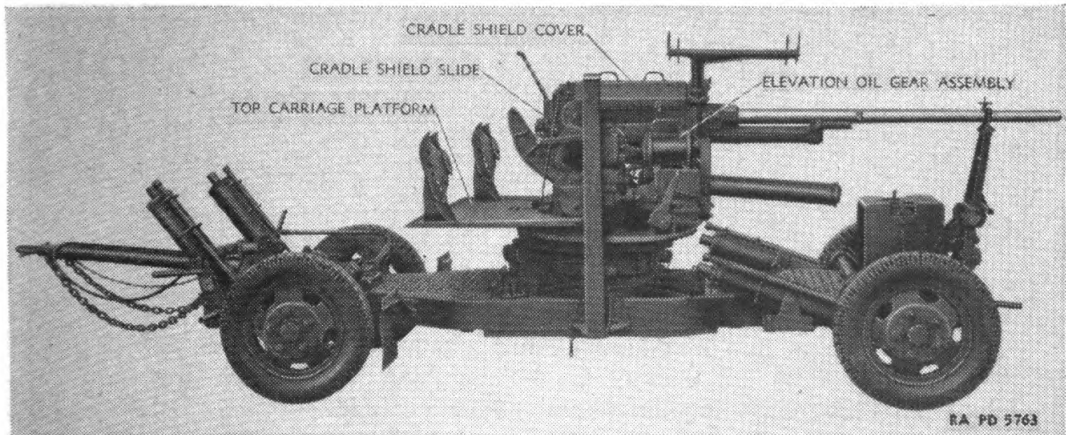


FIGURE 28.—37-mm AA gun carriage in traveling position.

- (6) Elevating mechanism.
- (7) Traversing mechanism.
- (8) Equilibrator mechanism.
- (9) Cradle.
- (10) Firing mechanism.
- (11) Outrigger assemblies.

**18. Chassis.**—The chassis of all three carriages are very much alike in construction. They consist of welded steel frames carrying the gun mount in traveling and supporting it during firing. Attached to the chassis are the wheels, steering mechanism, counterpoise cylinders, buffer spring suspensions, a gun support, outriggers, top carriage, and all maneuvering mechanisms. The carriage is towed by a prime mover. When ready for firing it is detached from the prime mover and, by means of proper assemblies, the chassis is lowered to the ground and the wheels are raised so that the entire weight is supported by the chassis.

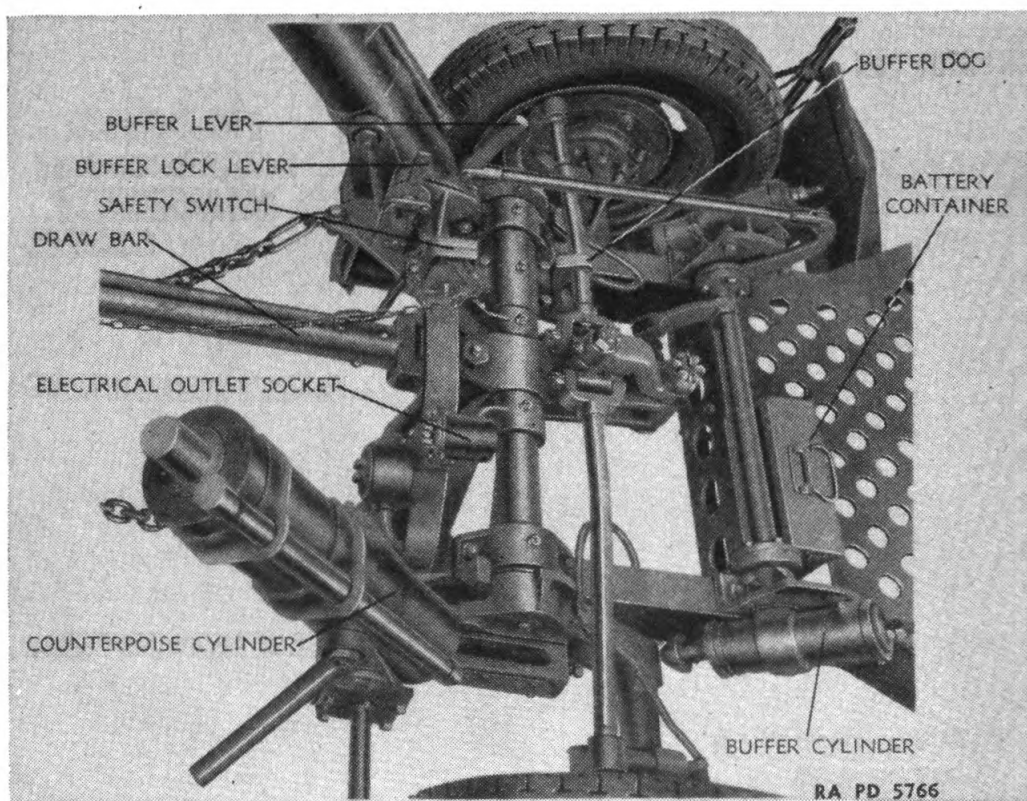


FIGURE 29.—Counterpoise cylinder and buffer mechanism.

**19. Counterpoise cylinders.**—The counterpoise cylinders (fig. 29) are pivoted to the side members of the chassis in front of each of the 4 wheels. The counterpoise rods are pinned in brackets on the rotating axle arms. Together with the buffer assemblies (fig. 29) they provide the spring suspension for road travel. The counterpoise springs also provide the counterbalance for the weight of the carriage, allowing the carriage to be lowered to the ground and lifted therefrom by man power. Long handles on the counterpoise cylinders give added leverage for rotating the axle arms. The ends of the counterpoise rods are so arranged in the axle arms that when forcing the



counterpoise cylinders down, the counterpoise rods raise the wheels, allowing the chassis to drop, and the counterpoise springs are compressed and hold the wheels off the ground. The reverse action occurs when manually lifting the chassis and rotating the buffer cylinder levers up. Adjustment of the counterpoise cylinders is possible by means of two adjusting nuts made available by removing the upper cap of the counterpoise cylinder.

**20. Buffer mechanism.**—The buffer cylinders (fig. 29) are pivoted to the side members of the chassis behind each of the 4 wheels. The front buffer cylinders are connected by a shaft as well as the rear buffer cylinders. A buffer lever and lock is provided to rotate each set of buffers into or out of position by rotating the shafts to which they are connected. The buffer shafts rotate in bearings on the chassis. Locks are provided for the buffer levers to prevent accidental movement. The front buffer lever is also arranged to lock the drawbar and steering mechanism in the straight forward position when the carriage is lowered. The buffer dog, which is welded to the right tie rod, fits into a socket on the buffer mechanism when the carriage is lowered and the drawbar is in a straight forward position. This prevents the drawbar from being moved while the carriage is emplaced.

**21. Brakes.**—*a. Service brakes.*—Electric brakes are provided on all wheels of the carriage. The two back wheels are supplied with hand brakes which are to be used when maneuvering the carriage by man power and when the carriage is not connected to the prime mover. A jumper cable carries current from the prime mover to the carriage for the operation of brakes and lights. The ends of the cable plug into sockets on the carriage and on the prime mover. When the carriage is detached from the prime mover a safety switch chain and the jumper cable must be separated from the prime mover. The electrical outlet socket (fig. 29) can be used for the loose end of the jumper cable when detached from the prime mover.

*b. Types of brakes.*—There are two different kinds of electric brakes on the 37-mm AA carriages. The lever type of brakes (Magdraulic electric) are on carriages having the letters "K.H." stamped on the backing plate of each brake. When the wheel and brake drums are removed, the brake will be seen to consist, in part, of a circular disk attached to the end of a long curved lever (fig. 73). The other type of brake is the disk brake (Warner electric) which is identified by a flat movable ring located concentrically around the wheel spindle.

*c. Safety switch.*—A safety switch ("breakaway" switch) (fig. 29) is provided to insure that the brakes on the carriage are applied if the

carriage breaks away from the prime mover. The switch is mounted on the front cross member of the carriage and is connected to the rear of the prime mover by a light chain. Current which is supplied to the brakes by the safety switch comes from a 6-volt battery mounted on the carriage (fig. 29). In case of an accidental separation between the carriage and prime mover, the chain attached to the prime mover pulls the switch, and the brakes on the carriage set instantly. After a breakaway, the switch must be placed in the "off" position so as not to exhaust the battery.

*d. Prime mover.*—The driver of the prime mover operates the brakes by means of a controller. The position of the hand lever of the controller determines the amount of current flowing from the battery of the prime mover to the brakes and consequently governs the intensity of the braking force. A load controller is also installed in the prime mover and is set by the driver. This adjustment allows the driver to regulate the braking power, thereby holding skidding to a minimum regardless of load or road conditions.

*e. Hand brakes.*—The hand brakes on the rear wheels of the carriage are set by pulling the brake levers forward. These are to be used only when the carriage is not connected to the prime mover.

**22. Lights.**—These carriages are equipped with two rear lamps each containing a tail and a stop light. They receive current from the prime mover through the jumper cable, and are operated from the prime mover. It is expected that blackout lights will be installed on these carriages. The blackout lights will consist of two lamps replacing the two now on the carriages. One of the lamps will contain a service tail, a service stop, and a blackout tail light. The other lamp will contain a blackout tail and blackout stop light. A blackout switch which will be installed at the point indicated in figure 31 will change from one set of lights to the other. The switch is operated by rotating the cover up and then twisting the slotted shaft with a screw driver or a coin.

**23. Leveling mechanism** (fig. 24).—The leveling mechanism is provided for placing the top carriage in a horizontal plane for firing. Two handwheels are provided for making this adjustment and two leveling vials for noting the level position of the top carriage. The motion of the leveling mechanism operates through a range of 10°.

**24. Elevating mechanism.**—*a. M3 and M3E1 carriages.*—The elevating mechanisms of these carriages are the upright posts to the right of the cradle. Two handwheels (fig. 24) are provided for elevating or depressing the gun and cradle. By sliding the handwheels laterally along their axis either a fast or slow motion can be obtained.

The limits of elevation are  $0^{\circ}$  and  $85^{\circ}$ , at which point the cradle will automatically stop. Slow motion of the handwheel will elevate the gun  $3.75^{\circ}$  for one turn of the handwheel and the fast motion will elevate the gun  $11.25^{\circ}$  for one turn of the handwheel.

*b. M3A1 carriage.*—The elevating mechanism of this carriage is found to the right of the cradle. There is one speed obtainable by the elevating crank (fig. 30). The gun and cradle are elevated  $4.67^{\circ}$  for each turn of the crank. The limits of elevation are  $-5^{\circ}$  to  $90^{\circ}$  when using the hand crank and  $0^{\circ}$  to  $85^{\circ}$  when using the remote control system.

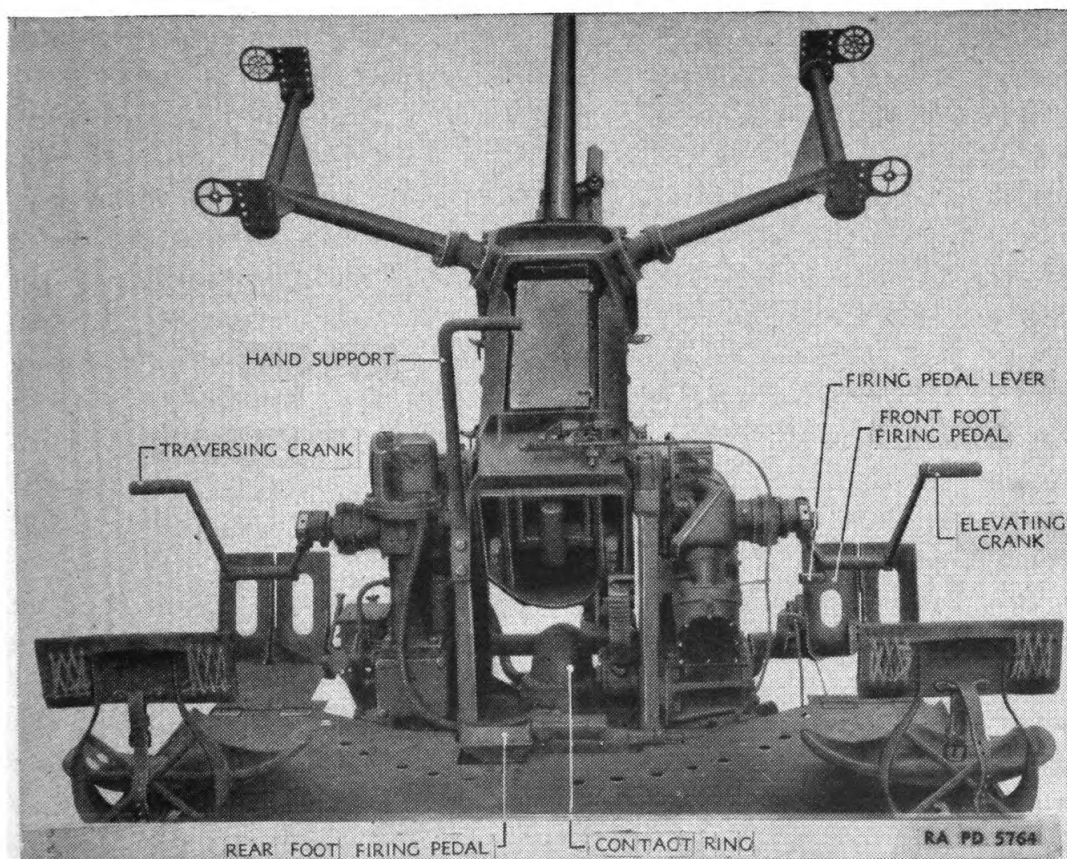


FIGURE 30.—Rear view of top carriage of 37-mm AA gun carriage M3A1.

**25. Traversing mechanism.**—*a. M3 and M3E1 carriages* (fig. 23).—The traversing mechanisms of these carriages are the upright posts to the left of the cradle. Two handwheels are provided for traversing the gun and cradle. By sliding the handwheels laterally along their axis either a fast or slow motion can be obtained. Complete  $360^{\circ}$  traverse is obtainable. Slow motion of the handwheel will traverse the gun  $3.75^{\circ}$  for one turn of the handwheel and the fast motion will traverse the gun  $11.25^{\circ}$  for one turn of the handwheel.

*b. M3A1 carriage.*—The traversing mechanism of this carriage is found to the left of the cradle. There is one speed obtainable by the hand crank (fig. 30) of the traversing mechanism. Three hundred sixty degrees (360°) traverse is obtainable.

**26. Equilibrator mechanism** (fig. 24).—The equilibrator counterbalances the handwheel load when elevating or depressing the gun and cradle. The equilibrators of these carriages are spring operated. Rods are used to connect the equilibrators of the M3 and M3E1 carriages to the cradles, whereas a chain is used for the M3A1 carriage. When the gun is lowered the equilibrator spring is compressed and when elevated, the spring is extended. Adjustment of the equilibrator mechanism is possible by means of two adjusting nuts made available by removing the front cap of the equilibrator.

**27. Cradle.**—The cradle is secured to the top carriage by means of the trunnion blocks. The elevating rack used for elevating the cradle is bolted to the bottom of the cradle and meshes with the elevating pinion at the base of the elevating mechanism. The equilibrator is attached to the back end of the cradle by means of a rod for the M3 and M3E1 carriages and a chain for the M3A1 carriage. A horizontal slideway in each side plate of the cradle is used for locating and securing the gun. Two gun mounting keys bolted to the front of the cradle lock the gun in position. The M3E1 cradle contains brackets on the right and left side for mounting the caliber .50 machine guns. The M3A1 cradle is provided with a set of cover plates and removable covers that totally enclose the gun when not in use.

**28. Firing mechanism.**—*a. M3 carriage* (fig. 32).—The elevating operator is provided with two foot pedals, the left one acting as a control for firing the gun. This foot pedal is provided with a latch lever which is located to the left of the pedal. The operator fires the gun by disengaging the latch, doing so by pressing the lever to the left and then pushing the pedal down. The gun trigger remains pulled as long as the foot pedal is depressed. When pressure on the pedal is released the pedal rises and the latch automatically locks the pedal. A mechanical system of levers and links carries the motion of the foot pedal through the right trunnion bearing to the trigger connector bracket lever which passes through the hole of the trigger.

*b. M3E1 carriage* (fig. 32).—The firing mechanism for the 37-mm gun is the same as that on the M3 carriage. The firing mechanism for the two caliber .50 machine guns consists of a foot treadle assembly bolted to the lower portion of the elevating mechanism gear case. This foot treadle is operated by the right foot of the elevating operator. Two cables run from this treadle, one to each of the two caliber .50



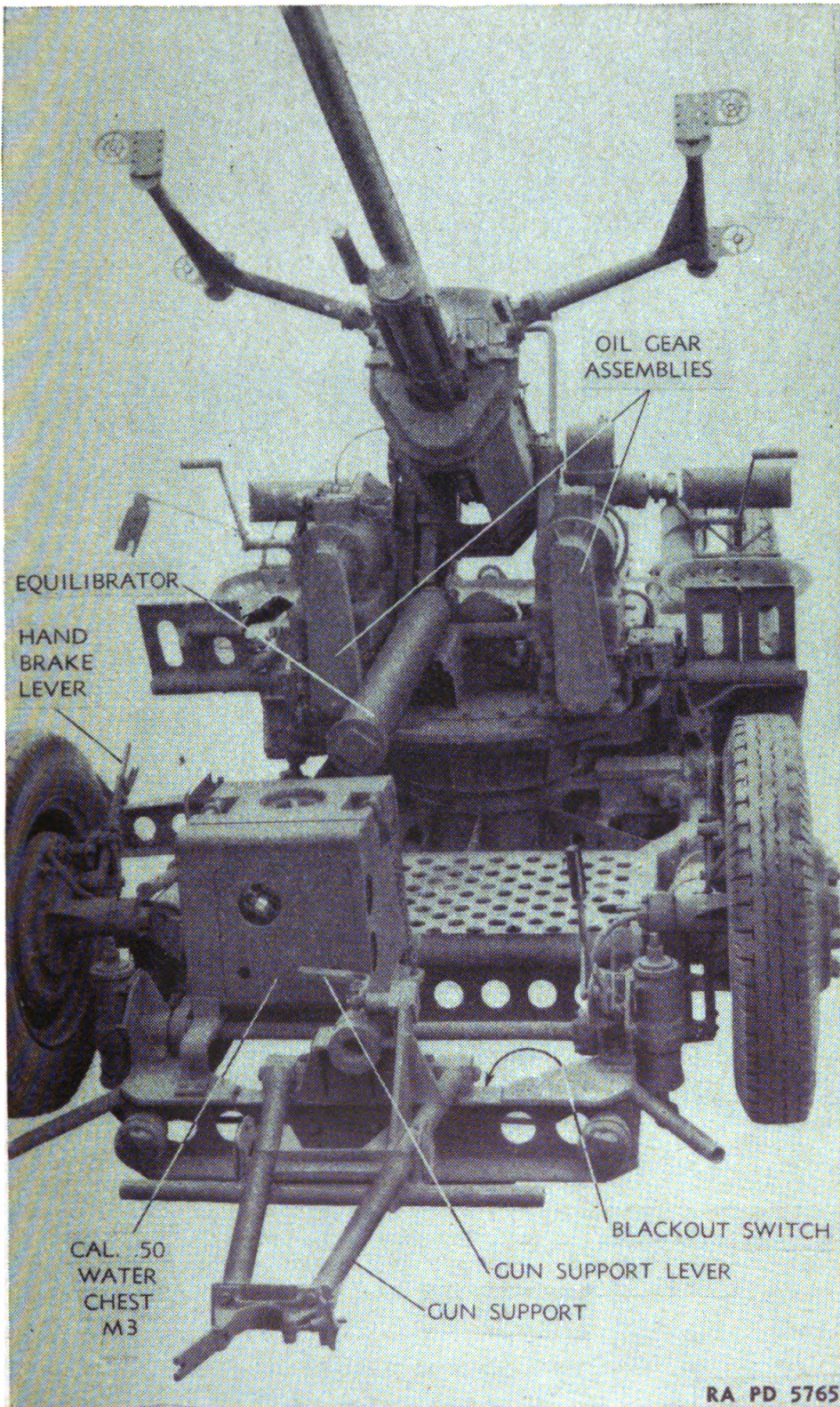


FIGURE 31.—Rear view of M3A1 carriage in firing position.



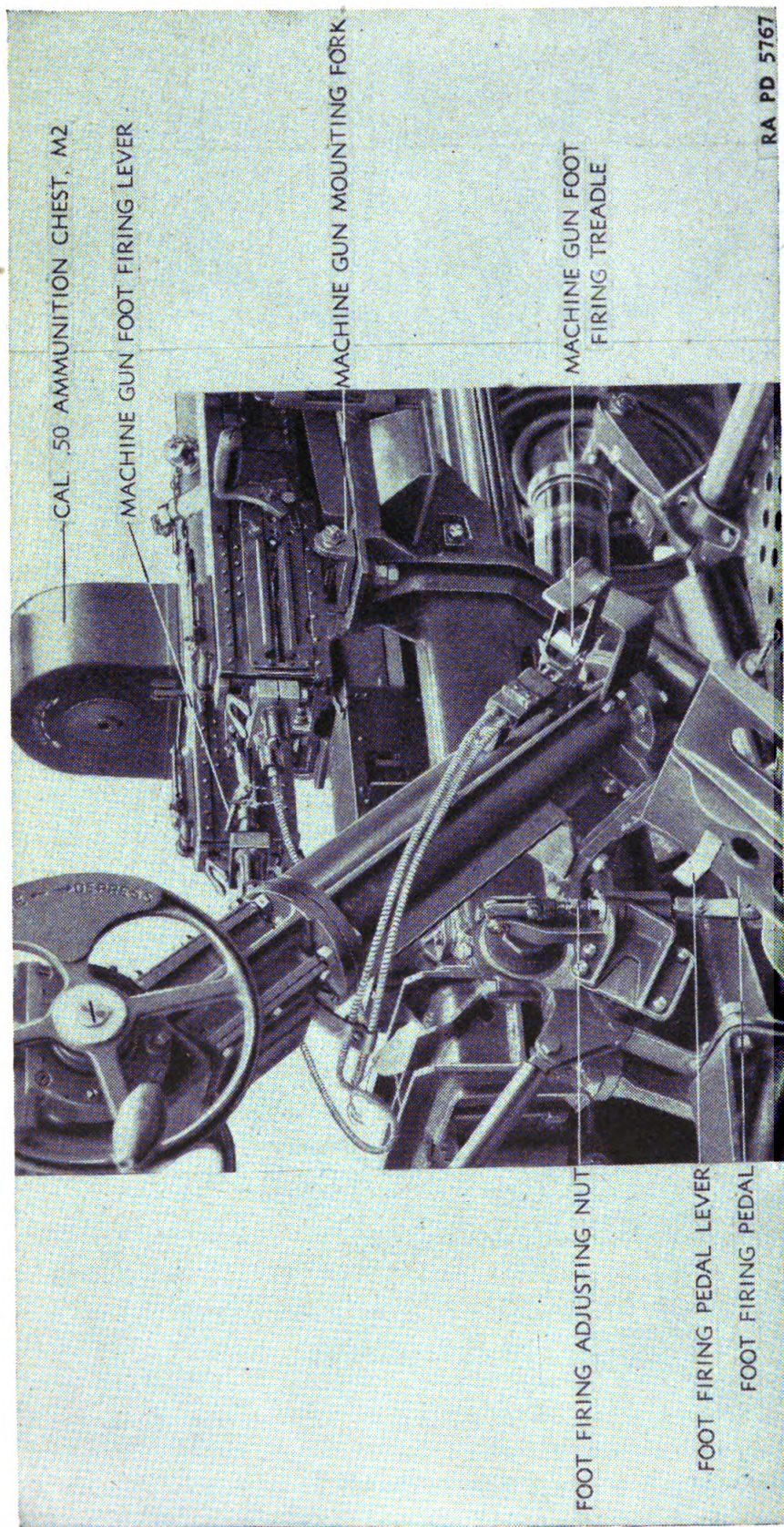


FIGURE 32.—Foot-firing mechanism for 37-mm gun and two caliber .50 guns.



machine guns mounted on the sides of the cradle. Either one of the cables can be disconnected from the machine gun by means of the machine gun foot firing lever found at the point where the cables are connected to the trigger mechanism (fig. 32).

c. *M3A1 carriage*.—A foot pedal similar to that on the M3 and M3E1 carriages is provided for firing the 37-mm gun. In addition the rear

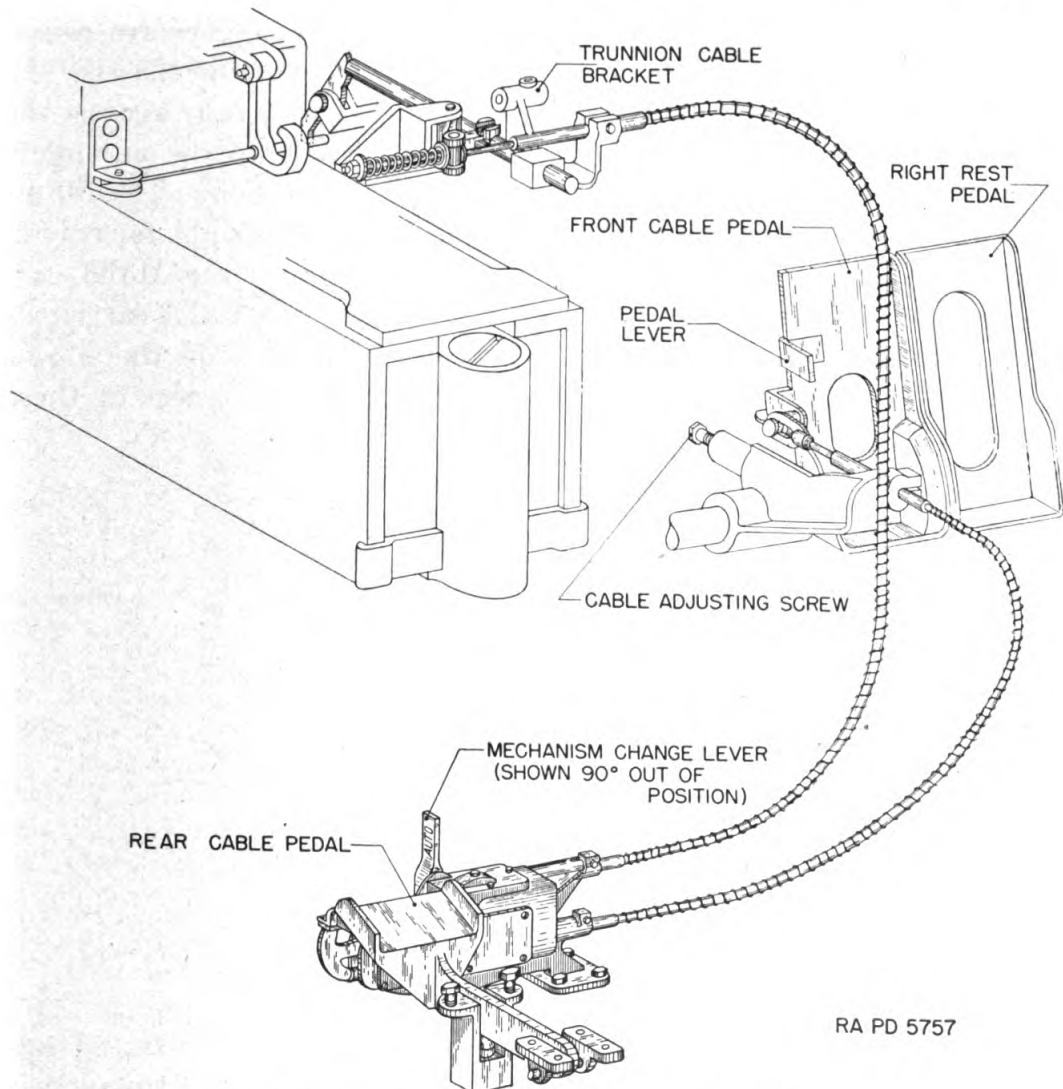


FIGURE 33.—Firing mechanism of M3A1 carriage.

cable pedal (figs. 30 and 33) which is located on the firing platform directly behind the cradle, can also be used to fire the gun. This pedal has no latch. The mechanism change lever is provided to change the type of firing. When this lever points to the right the word **AUTO** is shown and operation of each pedal will provide full automatic firing of the gun. When this lever is pointed to the left the word **FOOT** is

shown and firing will be semiautomatic when operating with either foot pedal. A mechanical system of levers, links, and cables carries the motion of the front and rear cable pedals to the trigger of the gun. The trunnion cable bracket is used for mounting the subcaliber equipment (par. 153).

**29. Outrigger assemblies (fig. 25).**—Two outriggers attached to the side members of the chassis give stability to the carriage about its longer axis. When in traveling position these outriggers are raised and secured so that they stand upright on each side of the chassis. In firing position the outriggers are lowered so that they bear against the ground. The M3E1 carriage has provisions for carrying the outriggers alongside the chassis rather than in an upright position. The M3A1 carriages are now made so that the outriggers stand upright for traveling. However, if these carriages are made by converting M3E1 carriages, the outriggers will be carried as on the present M3E1 carriages. Side plates which are part of the firing platforms of the M3A1 carriages, must be folded back when raising the outriggers of these carriages.

## SECTION IV

### OPERATION

	Paragraph
To place carriage in firing position.....	30
To check recoil oil in recuperator.....	31
To traverse top carriage.....	32
To elevate gun.....	33
To load.....	34
To fire.....	35
To recock.....	36
To cool gun tube.....	37
To unload.....	38
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**30. To place carriage in firing position.**—*a. Terrain.*—These carriages should be emplaced on level, smooth ground. If the terrain has a slope greater than 5°, the top carriage will not be properly leveled.

*b. Brakes.*—Safety switch should be in “off” position. Use hand brakes.

*c. Lowering carriage to ground (figs. 34 and 35).*—(1) Swing the drawbar so that it and the front wheels are in a straight forward position.

(2) While standing in front of the carriage pull the buffer lock lever to the right and pull the buffer lever forward as far as it will go. Let the buffer lock reengage the buffer lever in this position.

(3) Force the front end of the carriage down by pushing on the handles extending from the front corners of the counterpoise cylinder supports. If the carriage does not drop, extend the arms of the counterpoise cylinders and press down as shown in figure 34.

(4) When the chassis rests on the ground, continue rotating the counterpoise cylinders until the tires are off the ground.



FIGURE 34.—Lowering front of carriage to firing position.

(5) Lower the rear end of the chassis in the same manner as above (fig. 35).

*d. Lowering outriggers when carried in upright position.*—(1) Turn turnbuckle nut counterclockwise until the turnbuckle screw pin is disengaged from its socket on the outrigger (fig. 36).

(2) Lower the outrigger and force it into contact with the ground.

(3) Insert the turnbuckle screw pin into its other socket in the outrigger (fig. 37). Turn the turnbuckle nut counterclockwise until it is tight and holds the outrigger firmly against the ground.

(4) The other outrigger is treated in the same manner.



(5) The firing platform of the M3A1 carriage contains two hinged plates that lead from the platform to the foot pedals. These plates must be extended when the outriggers are lowered.

*e. Positioning outriggers when carried alongside the chassis frame.*—

(1) Loosen outrigger from traveling position by turning the turnbuckle nut counterclockwise.

(2) Elevate the free end of the outrigger about  $15^\circ$  until the pivoted end can be lifted from the supporting pin and lift the outrigger free from the carriage.

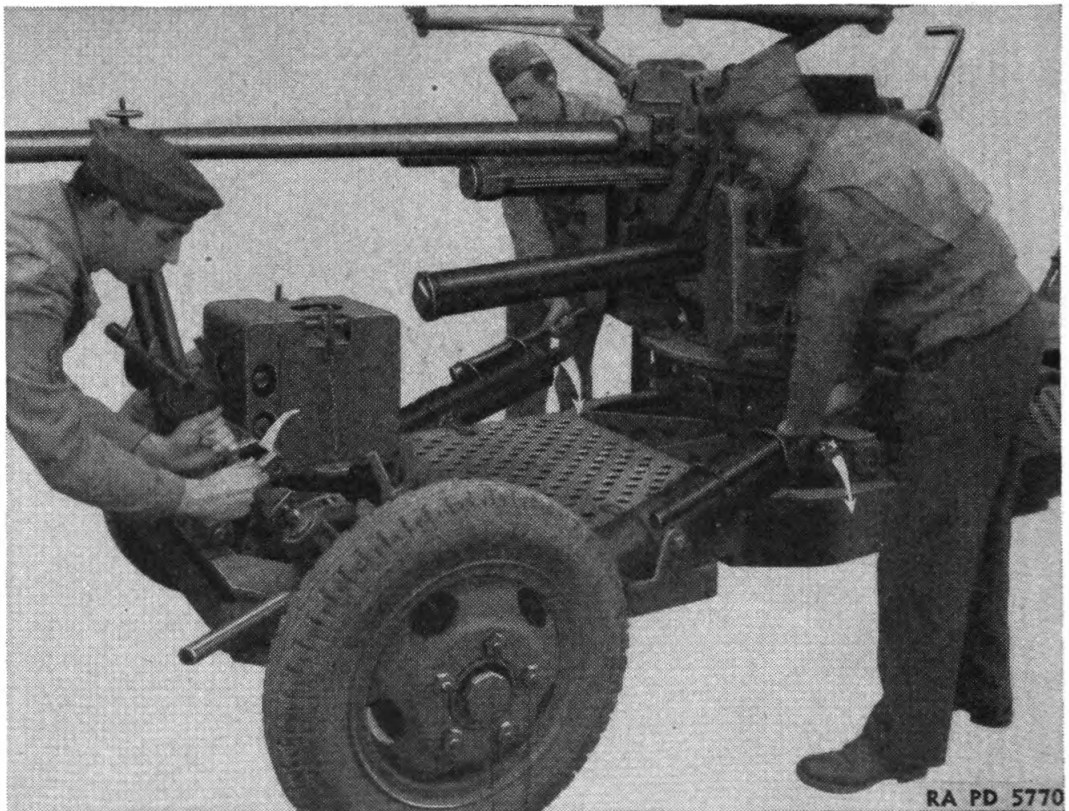


FIGURE 35.—Lowering rear of carriage to firing position.

(3) Place the outrigger over the pin below the turnbuckle and force the outrigger against the ground.

(4) Insert the turnbuckle screw pin into its socket in the outrigger. Turn the turnbuckle nut counterclockwise until it is tight and holds the outrigger firmly against the ground.

(5) The other outrigger is treated in the same manner.

*f. Lowering gun support.*—(1) Loosen the nut holding the clamp around the gun tube, swing nut down, and swing the clamp in the opposite direction (fig. 38).



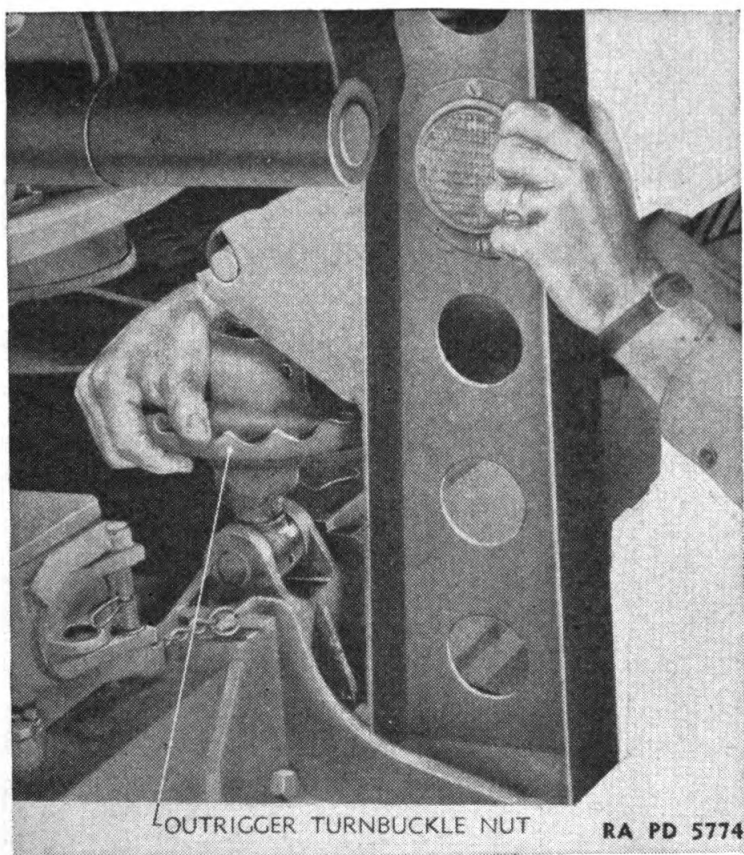


FIGURE 36.—Locking outrigger in traveling position.

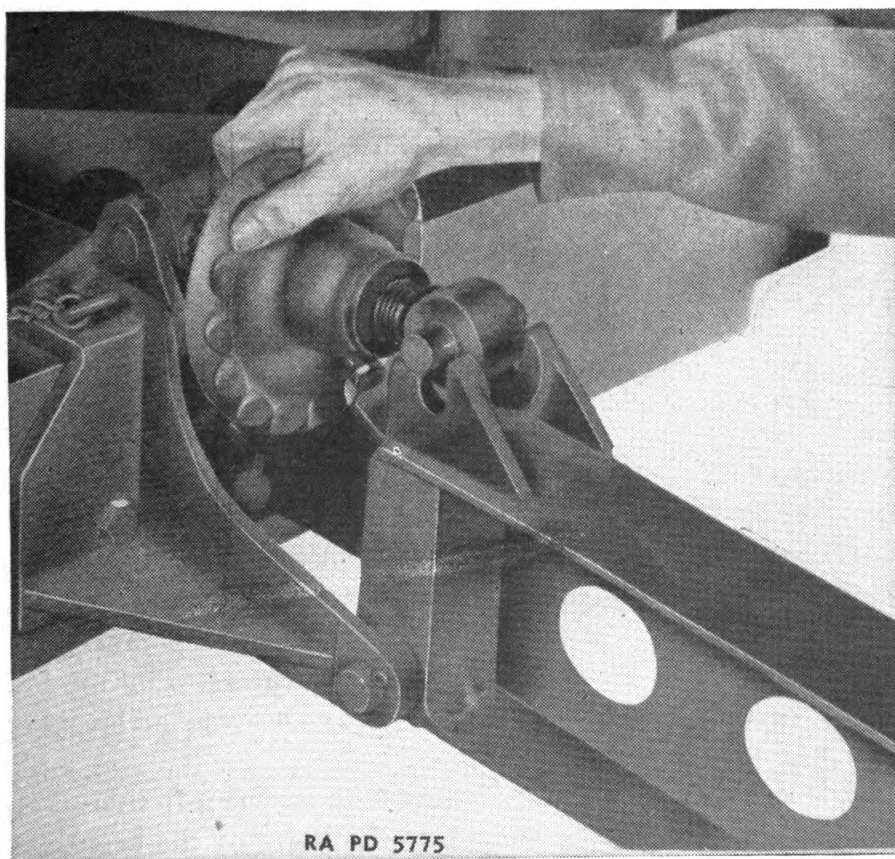


FIGURE 37.—Locking outrigger in firing position.

(2) Push the gun support lever (fig. 39) toward the center of the carriage and lower the gun support.

*g. Removing cradle shields from M3A1 carriages.*—(1) Turn the thumbscrews of the cradle shield slide to a vertical position and withdraw the slide (fig. 40).

(2) Unlatch both sides of the cradle shield cover. Lift the cover from the cradle (fig. 41).

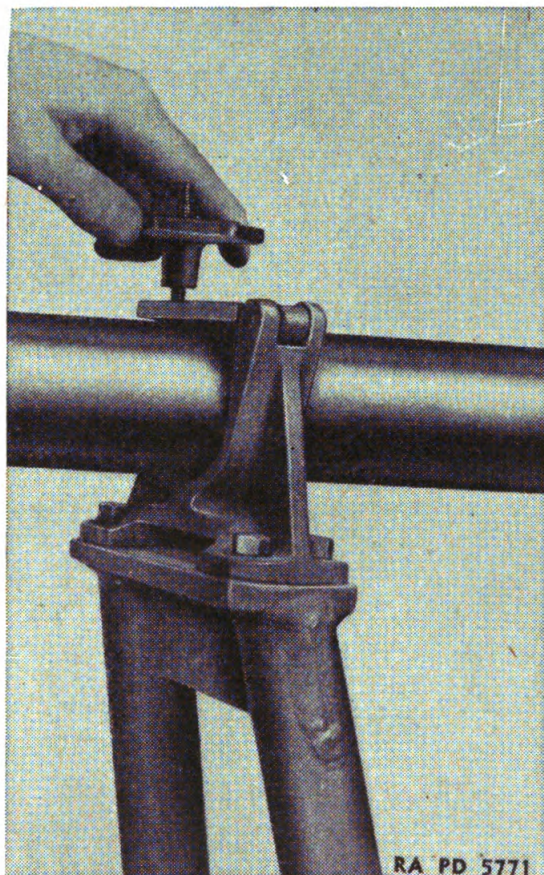


FIGURE 38.—Detaching gun tube from gun support.

*h. Leveling top carriage.*—Uncover the two leveling vials and level the top carriage by means of the two leveling handwheels on the M3 and M3E1 carriage or the two ratchet wrenches on the M3A1 carriage (fig. 42). During firing, care should be taken not to move the leveling mechanisms and disturb the level condition of the top carriage. This is important, since no locking devices are on the leveling mechanisms.

*i. Assembly of cartridge tray to gun.*—(1) Depress the levers on each side of the cartridge tray.

(2) Slide the tray down over its brackets on the left side of the gun far enough to let the latches snap into the holes of the brackets.



**31. To check recoil oil in recuperator.**—*a.* Elevate the gun to 5°.

*b.* Remove the recuperator filler screw and the expansion tube relief screw (fig. 1).

*c.* Note whether oil is just visible in the bottom of the recess in the bottom of the filling hole.

*d.* If not to this level, add oil as described in paragraph 51*c.*

*e.* If too much oil is present, remove the excess quantity.

**32. To traverse top carriage.**—*a. M3 and M3E1 carriage.*—The traversing gear ratio is changed by sliding the handwheels laterally along their axis.

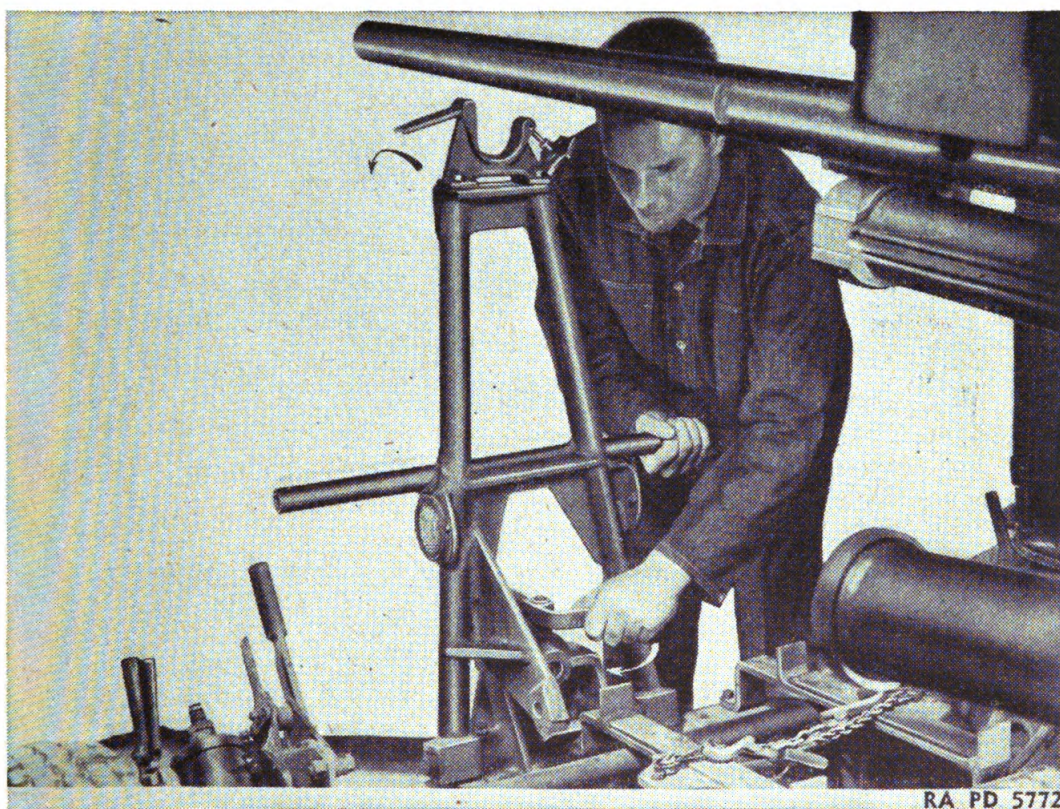


FIGURE 39.—Lowering gun support.

*b. M3A1 carriage.*—(1) The traversing crank is disengaged from the gear system by pulling the crank about  $\frac{1}{2}$  inch out along its axis.

(2) The crank can be removed from the mechanism by pulling out on the plunger located at the base of the crank and then sliding the crank off the square ended shaft.

**33. To elevate gun.**—*a. M3 and M3E1 carriage.*—(1) The elevating gear ratio is changed by sliding the handwheels laterally along their axis.

(2) Force should not be exerted on the handwheels when the elevation limiting stops are reached.



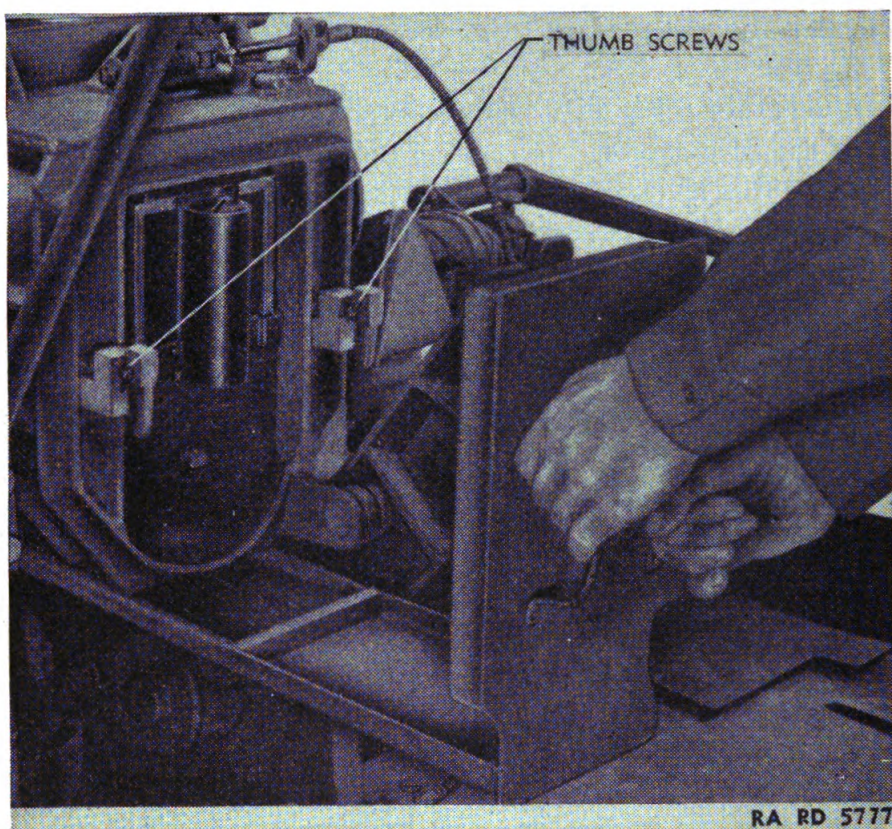


FIGURE 40.—Removing cradle shield slide from M3A1 carriage.

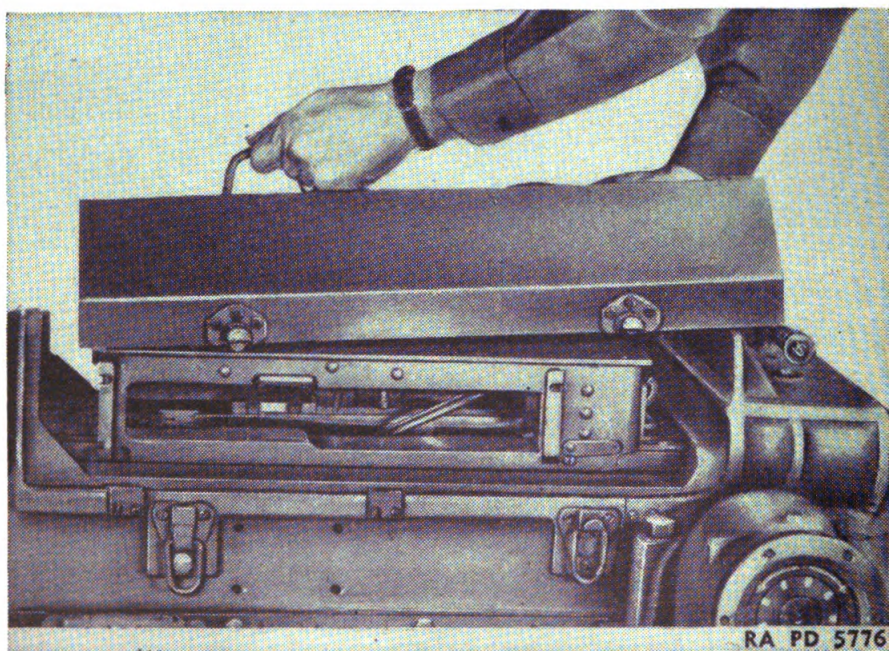


FIGURE 41.—Removing cradle shield cover from M3A1 carriage.



b. *M3A1 carriage*.—(1) The elevating crank is disengaged from the gear system by pulling the crank about  $\frac{1}{2}$  inch out along the axis.

(2) The crank can be removed from the mechanism by pulling out on the plunger located at the base of the crank and then sliding the crank off the square ended shaft.

(3) Force should not be exerted on the crank when the elevation limiting stops are reached.

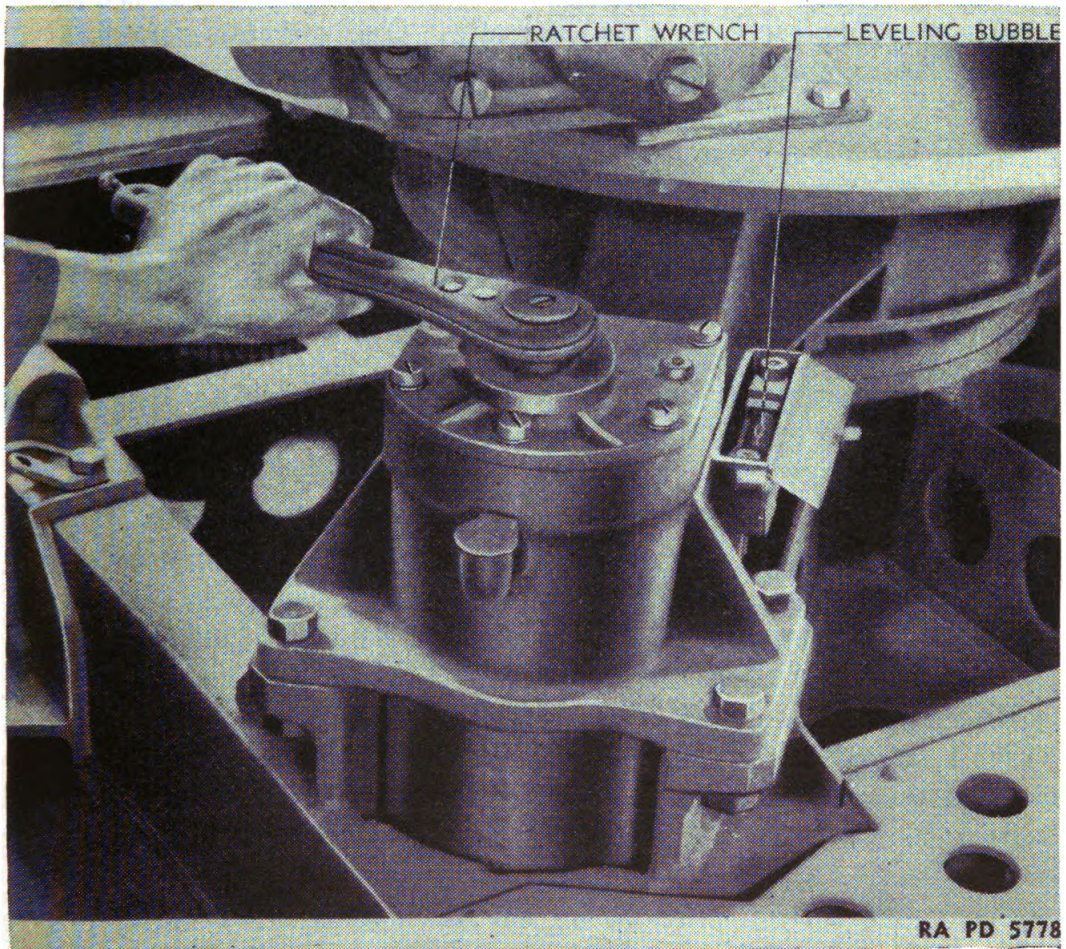


FIGURE 42.—Leveling top carriage of M3A1 carriage.

**34. To load.**—a. *Loading ammunition clip* (fig. 43).—(1) Place the clip, prongs up, on a flat surface.

(2) Place one round at a time on the clip so that the groove in the rotating band is in line with side wall projections.

(3) With one hand on the projectile and the other hand on the case, press the round straight down into place.

b. *Loading gun*.—(1) Inspect the bore and gun to see that no ammunition or foreign material is present.

(2) Open the feed box cover.



- (3) Raise the carrier until caught by the carrier catch.
- (4) Pull the lock frame to the rear until caught by the carrier dog. The priming rod is used to pull the lock frame rearward by hooking the rod into the operating lever.
- (5) Place loaded ammunition clip on ammunition tray, cartridge side down.
- (6) Close the feed box cover.
- (7) Push the ammunition clip into the feed box, using enough force to strip the first cartridge from the clip. The cartridge should trip the lock frame and be charged into the firing chamber without being fired.

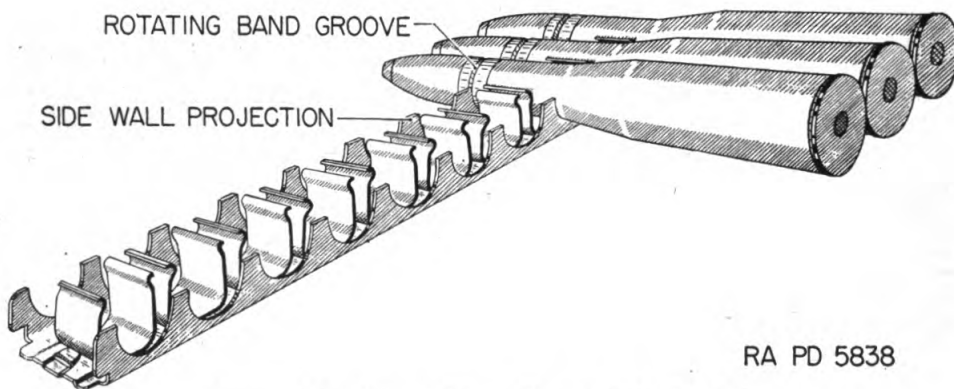


FIGURE 43.—Ammunition clip partially loaded.

*c. Continuous loading.*—(1) The automatic mechanisms feed in the ammunition clip without further help. However, other clips must be loaded and fed in as described below.

(2) A second clip is pushed lightly into contact with the first clip just before the last round of the first clip enters the feed box opening. Contact should be maintained until the feed slide pawl grasps the second clip.

(3) During certain portions of the recoil and counterrecoil cycles there are times when the ammunition clip is free to move through the feed box if pushed by the loader. If this occurs, more than one round will be fed into the receiver and the gun will jam. To prevent this, the loader should avoid exerting too much pressure on the clip being fired when following it up with a second clip.

(4) If the new clip is not caught by the feed mechanism and carried into the gun, then the clip will have to be pushed in hard enough to strip the first cartridge as described in *b* above.

(5) The empty clips should be caught as they come out of the right side of the feed mechanism.

**35. To fire.**—*a. M3 carriage* (fig. 32).—(1) The 37-mm gun on this carriage is fired by the elevation operator as follows:

(2) Push the foot-firing pedal lever to the left in order to unlatch the foot-firing mechanism.

(3) Depress the foot pedal to fire the gun. The trigger will remain pulled as long as the pedal is depressed. When the pedal is released, the trigger returns to normal position and the pedal lever locks the pedal in place.

(4) If the pedal is depressed while loading the gun, the cartridge will be fired as soon as it is charged into the chamber. If the cartridge is fed in first, it will remain unfired until the pedal is depressed.

*b. M3E1 carriage* (fig. 32).—(1) The 37-mm gun is fired the same as described in *a* above.

(2) The two cal. .50 machine guns are fired by depressing the machine gun foot-firing treadle. There is no latching device on this treadle.

(3) Either one of the machine guns can be detached from the firing mechanism cables as follows (fig. 32):

(*a*) Lift the snaplock and rotate the machine gun foot-firing lever forward.

(*b*) Pull out the pin which is secured by a chain.

(*c*) Reassemble in the reverse order.

*c. M3A1 carriage* (figs. 30 and 33).—(1) For full automatic fire, revolve the mechanism change lever to the right so that the word "AUTO" is up.

(2) For semiautomatic fire revolve the mechanism change lever to the left so that the word "FOOT" is up.

(3) The elevating operator can fire the gun in the same manner as for the M3 carriage.

(4) The rear cable pedal will also fire the gun. No latching device is provided for this pedal.

**36. To recock.**—*a.* Pull the lock frame back by means of the priming rod until the breechblock is lowered and then let the lock frame go forward.

*b.* For misfires, see paragraph 43.

**37. To cool gun tube.**—*a. General.*—The tube of the 37-mm gun should be water cooled after about 50 rounds of sustained fire at maximum rate. When single shots or bursts of less than 30 rounds are fired, the gun should be cooled after about 100 rounds. Never fire more than 100 rounds before cooling. If the block bushing grips the tube so that recoil is prevented, the tube is not being cooled often

enough, the gripping being caused by excessive expansion of the tube from the heat of firing.

*b. To cool gun tube.*—(1) Fill water chest with clean water. The chest capacity is 8 gallons.

(2) Remove caps from the inlet and outlet connections of the water chest.

(3) Connect the hose attached to the long curved brass pipe (the breech connection) to the outlet connection of the water chest.

(4) Connect the hose attached to the muzzle cap (fig. 44) to the inlet connection of the water chest. *Do not connect to the muzzle at this time.*

(5) Raise the carrier, then pull the lock frame to the rear until caught by the carrier dog, and elevate the gun to about 30°.

(6) Lift the breech connection up through the bottom of the gun and insert it into the breech opening through the tube extension as far as it will go.

(7) Ease the lock frame forward slowly so that the operating lever will hold the breech connection in place (fig. 46).

(8) Remove cover from the water chest, place the pumping handle into position, and pump water up into the gun tube so that the tube is full of water. The pump handle should be turned clockwise as indicated by the arrow on the water chest cover.

(9) When steam stops coming out of the tube, connect the muzzle cap to the tube. The cap should be placed over the muzzle and the handle turned clockwise to tighten the cap in place (fig. 45).

(10) Pump water through the gun tube for 2 or 3 minutes or until a man can place his bare hand lightly on the gun tube without being burned.

(11) When the tube has been cooled open the hand hole in the top of the water chest.

(12) Disconnect the muzzle connection from the gun and allow the water to drain back into the chest.

(13) Turn the pump handle counterclockwise until the water in the gun tube is pumped into the chest.

(14) Pull the lock frame to the rear and remove the breech connection.

(15) Allow the gun tube to drain and thoroughly dry it.

(16) Coat the bore with oil, engine, SAE 10 below 32° F. or SAE 30 above 32° F.

**38. To unload.**—*a. To remove ammunition clip.*—(1) Fold back feed box cover.

(2) Pull out on the cartridge feeder pawl handle and feed pawl button at the same time.

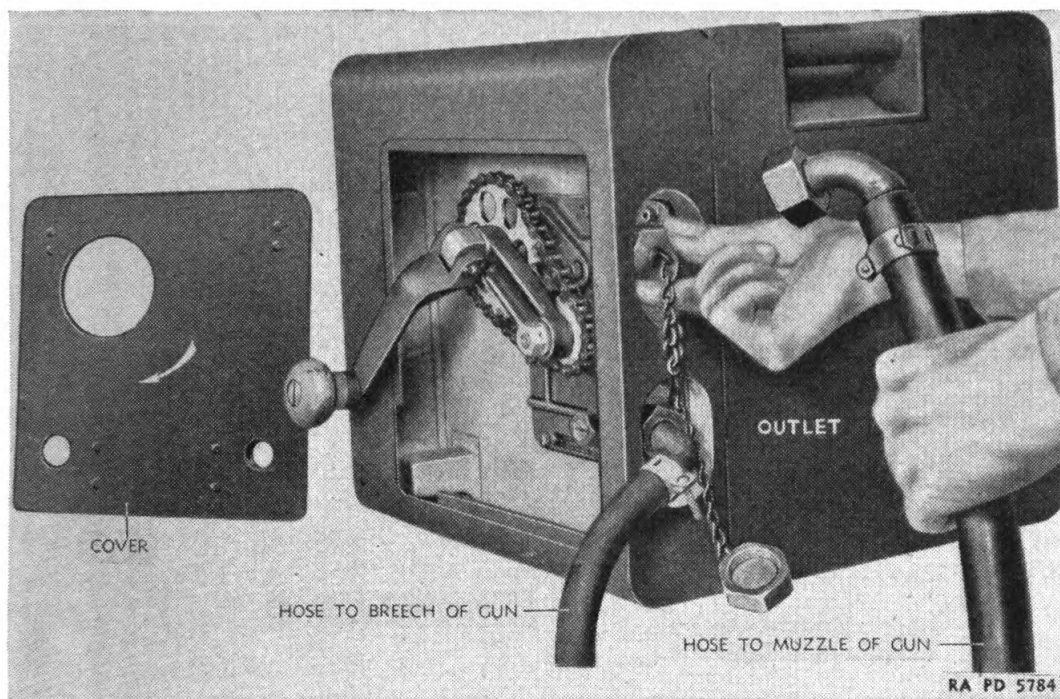


FIGURE 44.—Connections to caliber .50 water chest M3.

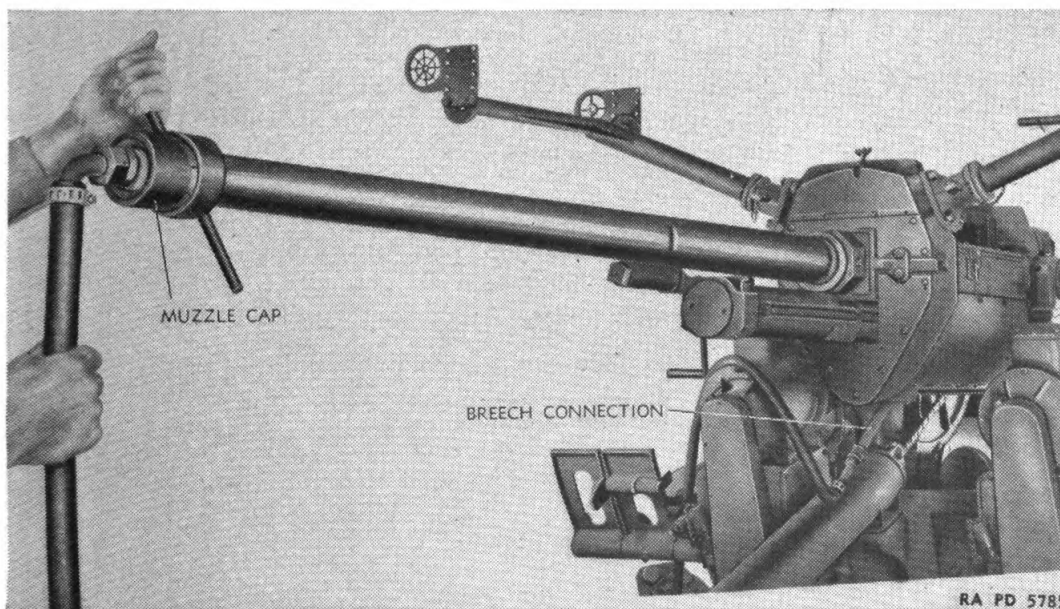


FIGURE 45.—Securing muzzle cap of cooling system.

(3) Draw the ammunition clip out of the feed box of the gun.

*b. To remove cartridge from chamber.*—(1) Raise the carrier until caught by the carrier catch.

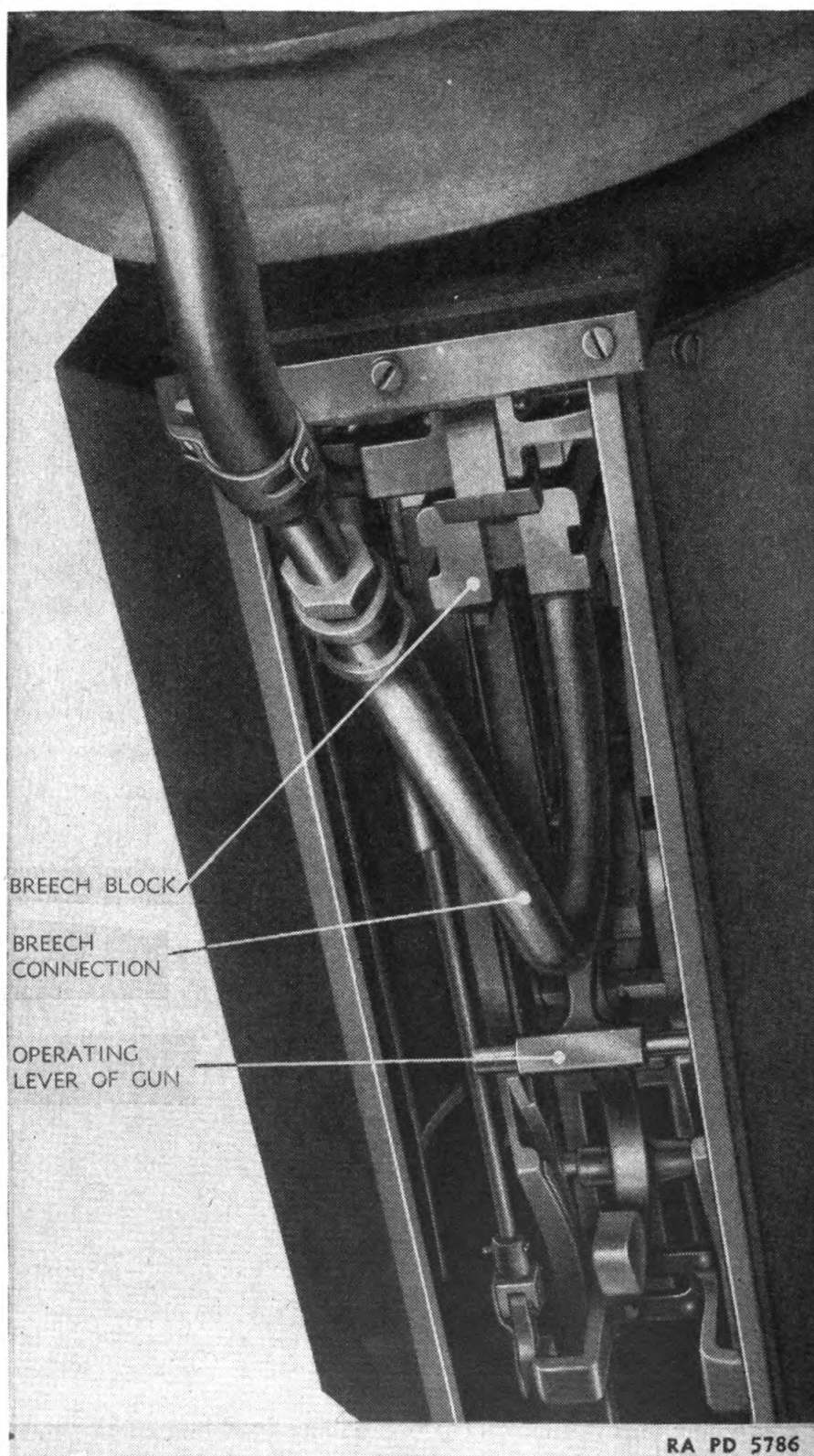


FIGURE 46.—Installation of breech connection of cooling system.



(2) Retract the lock frame until caught by the carrier dog. The extractor will withdraw the round, and it will fall out through the bottom of the gun.

(3) Examine the chamber to see that it is empty.

(4) Push the carrier catch to the right to allow the lock frame to go forward.

*c. To empty ammunition clip.*—(1) Place the clip on a flat surface with the rounds up.

(2) Grasp a projectile with one hand and its case with the other, and with the thumbs pressing downward against the clip or adjacent cartridges, pull straight up.

**39. To place in traveling position.**—*a.* Follow the reverse order of placing in firing position as described in paragraph 30.

*b.* If the carriage has sunk into the ground the full length of the spade beneath the chassis, difficulty may be encountered in pushing the wheels down far enough to allow the counterpoise cylinders to be rotated. Remove sufficient earth from under the wheels to allow them to be sufficiently depressed.

*c.* Setting the wheels parallel to the side frames of the carriage brings the dog on the tie rod into such a position that as the carriage drops into firing position the dog follows the slot on the buffer tie rod. While the carriage is down in firing position, the buffer locking lever should engage the other end of the arc on the buffer lever. This will prevent the dog slipping out of the slot. However, before attempting to raise the carriage, a check should be made to see that the dog will follow the slot as the carriage comes up. If the dog does not follow the slot, the carriage will jam badly.

*d.* The buffer locking levers must be fully engaged whenever the carriage is in traveling position. Failure of the locking lever pin to engage fully in its seat may result in that end of the carriage dropping to firing position while being towed. This may cause a serious accident. If this fault develops, either the locking pin seat should be reamed out, or the pin worked down with fine emery cloth until engagement is easy and positive.

**40. To load cal. .50 machine gun.**—Loading may be considered to include two distinct operations: entering the loaded belt properly into the belt opening, and thereafter operating the mechanism of the gun until it is closed with the cartridge in the chamber and a cartridge in the feedway gripped by the extractor for extraction on the next recoil stroke. The double loop end of metallic link belt should always be inserted regardless of whether right- or left-hand feed is employed.

*a.* The first of these operations may be performed with the cover

either open or closed. In either case, enter the double loop end of the belt through the feed opening until the first cartridge is beyond the belt holding pawl. Close the cover, if open. Pull the bolt completely to the rear by means of the retracting slide and release it.

*b.* The second operation consists of pulling the bolt once completely to the rear and then allowing it to spring forward. This operation must start with the action fully closed and the extractor gripping the cartridge in the feedway.

**41. To unload cal. .50 machine gun.**—*a.* Lift cover, remove belt, retract bolt, and make visual inspection of feedway, T-slot, and chamber to make certain that gun is unloaded.

*b.* Release bolt and lower cover.

*c.* Press trigger or sear mechanism to relieve tension on firing pin spring.

## SECTION V

### MALFUNCTION AND CORRECTION

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**42. General.**—*a.* A malfunction is an improper action of some part of the gun, resulting in a stoppage; for example, failure to extract the empty cartridge case.

*b.* Any accidental cessation of fire is a stoppage. It may be a faulty cartridge or a malfunction of some part of the gun.

*c.* Immediate action is the term applied to that operation required to clear a temporary stoppage or malfunction.

*d.* Proper care of the gun and attention to the points before, during, and after firing will greatly reduce the liability to stoppages, particularly if the gunner has an intelligent understanding of the reason why stoppages generally occur. Prevention is the best remedy for all stoppages. See paragraph 58 for proper inspection procedures.

**Caution:** After any stoppage make sure that the bore is clear before continuing firing. It is possible that a stoppage caused, for instance, by incomplete ignition of the powder charge, may result in the bullet lodging in the bore, and in case this happens and another round is fired before the bore is cleared, the gun certainly will be seriously damaged.

*e. Classes.*—Stoppages may be classed under two main headings:

(1) *Temporary.*—Temporary stoppages are caused by—

(a) Failure of some part, duplicate of which is carried with the gun.

(b) Faulty ammunition.

(c) Neglect of points before or during firing.

(2) *Prolonged.*—Prolonged stoppages are caused by a failure of some part that, as a rule, cannot be remedied by the gun squad under fire or without skilled assistance. These necessarily put the gun out of action for a more or less prolonged period.

**43. Misfire.**—In the event a round does not fire when the firing pin hits the primer, the following operations are to be followed:

a. Wait 5 minutes if practical.

b. Recock the gun by pulling the operating lever to the rear until the breechblock comes to the bottom position. This should be done with the priming rod.

c. Release the operating lever, making sure the breechblock is entirely closed.

d. Attempt to fire the gun.

e. If the gun does not fire the second time, unload and examine the firing pin and firing pin spring for malfunctioning.

f. If the firing pin and spring are not at fault, further examination or disassembly will be necessary to trace the cause of misfire.

#### 44. Gun.

Malfunction	Cause	Correction
a. Fails to fire; no percussion on primer.	a. Broken firing pin.	a. Replace with new pin.
b. Cartridge case not extracted.	b. Broken or weak extractor spring.	b. Replace with new spring.
c. Lock frame fails to drive forward.	c. (1) Driving spring assembly is not attached or is broken. (2) Dirty or broken carrier assembly.	c. (1) Attach or replace spring assembly. (2) Clean, or replace if broken.
d. Lock frame fails to fire round.	d. (1) Recoil piston not properly positioned. (2) Broken or malfunctioning spring or pin. (3) Foreign matter keeps the block from closing. (4) Broken firing hammer or spring.	d. (1) Notify ordnance personnel. (2) Replace. (3) Clean. (4) Replace.



Malfunction	Cause	Correction
<i>e.</i> Lock frame fails to function.	<i>e.</i> (1) Accelerator fails to function. (2) Carrier dog fails to function. (3) Foreign matter in operating cams.	<i>e.</i> (1) Replace.  (2) Replace carrier assembly. (3) Clean.
<i>f.</i> Accelerator fails to function.	<i>f.</i> (1) Broken or weak spring. (2) Damaged accelerator cam.	<i>f.</i> (1) Replace with new spring. (2) Repair or replace cam.
<i>g.</i> Operating lever fails to function.	<i>g.</i> Broken or weak spring.	<i>g.</i> Replace with new spring.
<i>h.</i> Failure to operate at high angles of elevation.	<i>h.</i> (1) Gun fails to return entirely into battery due to dirt or foreign matter in moving parts. (2) Lubricant on moving parts too heavy or has become sticky due to cold or age. (3) Oil in recoil mechanism too heavy due to cold or other conditions.	<i>h.</i> (1) Clean moving parts.  (2) Remove all lubricant with solvent, dry-cleaning. Lubricate with proper grade of oil, engine. (3) Under cold temperatures where gun is standing by for emergency firing a hood should be placed under the gun inclosing a gasoline stove. This will keep the recoil oil warm enough for instant firing. During firing enough heat is generated to keep the recoil oil satisfactory.
<i>i.</i> Failure of driving springs to charge the lock frame and round forward.	<i>i.</i> (1) Bent or burred driving spring rods.  (2) Dented driving spring covers. (3) Excessively heavy or gummy lubricant in driving spring assemblies.	<i>i.</i> (1) Remove burs and straighten driving spring rods.  (2) Replace driving spring assembly. (3) Correct as indicated in paragraph 59 <i>e</i> .
<i>j.</i> Failure to operate at low angles of operation.	<i>j.</i> (1) Same as in <i>h</i> above. (2) Ejected cartridge case striking the mount and rebounding between the lock frame and tube extension.	<i>j.</i> (1) Same as in <i>h</i> above. (2) Draw lock frame to the rear and allow the case to fall clear of the gun.

Malfunction	Cause	Correction
<p><i>k.</i> Gun fires when loaded, firing pedal not depressed.</p> <p><i>l.</i> Failure to feed.</p> <p><i>m.</i> Gun jams on sustained fire due to feeding more than one round at a time.</p> <p><i>n.</i> Two clips locked in the feed box during sustained firing.</p> <p><i>o.</i> Oil leak from rear stuffing box of recuperator.</p> <p><i>p.</i> Failure to eject.</p> <p><i>q.</i> Breechblock fails to operate.</p>	<p>(3) Failure to extract due to broken or weakened extractor spring.</p> <p><i>k.</i> Dirt, grit, or heavy gummed lubricant on the trigger bar which lies on the side of the feed box and connects the trigger with the trigger lever.</p> <p><i>l.</i> Weak spring in the carrier failing to force the round into the gun.</p> <p><i>m.</i> Excessive pressure exerted on the ammunition clip by the loader.</p> <p><i>n.</i> A worn feed pawl or a faulty location of the feed pawl which places it too far to the left in the feed slide.</p> <p><i>o.</i> Wear of stuffing box.</p> <p><i>p.</i> (1) Broken or weak spring. (2) Damaged ejector cam. (3) Exact cause not known. It might be due to insufficient recoil but other minor irregularities of action might also be the cause.</p> <p><i>q.</i> (1) Damaged firing pin or spring. (2) Damaged breechblock.</p>	<p>(3) Replace spring.</p> <p><i>k.</i> Disassemble gun, clean and lubricate the trigger bar. It may be necessary for an ordnance mechanic to enlarge the recess of the bar slightly.</p> <p><i>l.</i> Replace carrier assembly.</p> <p><i>m.</i> The loader should not exert a pressure on the clip during firing and should be particularly careful to avoid such pressure in following one clip with another during sustained firing.</p> <p><i>n.</i> Replace parts. Training of the loader will assist in avoidance of this malfunction.</p> <p><i>o.</i> If leak is slight the gun should be kept in service and the leakage overcome by frequent fillings of the recoil cylinder. If leak becomes serious, or if time permits, the gun must be turned over to ordnance maintenance personnel for repair.</p> <p><i>p.</i> (1) Replace with new spring. (2) Notify ordnance personnel. (3) Maintain the recoil mechanism, as well as all other parts of the gun, in perfect working condition.</p> <p><i>q.</i> (1) Replace with new parts. (2) Smooth down, lubricate, and reuse. If not suitable, replace.</p>

**45. Carriage.**

Malfunction	Cause	Correction
<p><i>a.</i> Wheels drop and counterpoise cylinders snap up during firing.</p> <p><i>b.</i> Road shock too severe.</p> <p><i>c.</i> Top carriage cannot be leveled.</p>	<p><i>a.</i> Improper adjustment of counterpoise cylinders.</p> <p><i>b.</i> Buffer mechanism out of adjustment.</p> <p><i>c.</i> (1) Terrain not level.</p> <p>(2) Leveling mechanism binds.</p>	<p><i>a.</i> Adjust as described in paragraph 60b. In this case turn adjusting nut clockwise.</p> <p><i>b.</i> Adjust as described in paragraph 60f.</p> <p><i>c.</i> (1) Emplace carriage on level ground.</p> <p>(2) Report to ordnance maintenance personnel.</p>

**46. Electric brakes.**

Malfunction	Cause	Correction
<p><i>a.</i> No brakes, or intermittent brakes.</p>	<p><i>a.</i> (1) Broken wire in circuit.</p> <p>(2) Broken wire or magnet.</p> <p>(3) Controller defective.</p> <p>(4) Poor connections at brake, controller, or plug and socket.</p> <p>(5) Defective plug or socket.</p>	<p><i>a.</i> (1) Check entire wiring for broken wires. Repair or replace.</p> <p>(2) If broken wire is on outside of brake, repair if possible. If no current flows through magnet, notify ordnance personnel (par. 61a).</p> <p>(3) Short out controller by connecting both wires to one terminal and see if brakes are effective. If they are, replace controller.</p> <p>(4) Clean and tighten all connections.</p> <p>(5) Check plug and socket for loose connections, dirty or corroded blades, or broken socket. Repair or replace with new socket.</p>
<p><i>b.</i> Very weak brakes.</p>	<p><i>b.</i> (1) Worn out.</p> <p>(2) Glazed magnet facing.</p>	<p><i>b.</i> (1) Report to ordnance personnel.</p> <p>(2) Roughen face of magnet with coarse emery cloth.</p>



Malfunction	Cause	Correction
<b>c. Brakes grabbing.</b>	(3) Foot control out of adjustment on prime mover.	(3) When carriage brakes are adjusted, pedal travel is shortened. This throws controller out of adjustment. Reset controller with new pedal travel to cover full range of controller.
	(4) Insulation of wire broken. Loose connection.	(4) Check wiring for defective parts.
	(5) Insufficient current.	(5) Clean and tighten all connections, check plug and socket for corroded or dirty blades or broken socket. Replace broken parts.
	(6) Poor connection at brakes.	(6) Clean and make good connections at brake.
	(7) Worn wheel bearings.	(7) Replace bearings.
	c. (1) Loose or worn wheel bearings.	c. (1) Tighten or replace bearings.
	(2) Sticky or grease-coated lining.	(2) Notify ordnance personnel.
	(3) Drums out of round.	(3) Notify ordnance personnel.
	(4) Only one brake working.	(4) Check current at brakes with ammeter (par. 61a). Check for poor connections and partly broken or worn wires and make necessary repairs.
	(5) Broken or weak band spring.	(5) Notify ordnance personnel.
<b>d. Brake drag.</b>	(6) Controller burned out.	(6) Replace with new controller.
	(7) Contactor arm in controller pitted.	(7) Smooth contactor arm with fine emery cloth.
	(8) Broken magnet spring.	(8) Notify ordnance personnel.
	(9) Bushing in magnet worn out.	(9) Notify ordnance personnel.
	d. (1) Drums out of round.	d. (1) Notify ordnance personnel.
	(2) Broken spring in hand control.	(2) Replace with new spring.
	(3) Band distorted, unequal clearance.	(3) Notify ordnance personnel.

**47. Malfunctions of cal. .50 machine gun.—***a. Recurring short rounds.*—Excessive wear of the parts of the feed mechanism may cause recurring short rounds. Inspection of the base of the first cartridge removed from the belt will show a dent in the rear end of the case made by the corner of the extractor. This stoppage is remedied by inspecting feed mechanism and replacing defective parts. Inspection of ammunition belts before firing will disclose short rounds inherent in the ammunition.

*b. Loose bullets.*—In some lots of ammunition which have deteriorated from storage or exposure, the front end of the case is not securely crimped on the bullet. When the extractor withdraws the cartridge from the belt the case only is withdrawn, leaving the bullet in the belt. Loose powder scattered in the mechanism may cause a stoppage. This stoppage is remedied by removing the obstruction. The best prevention of this type of stoppage is a rigid inspection of ammunition prior to firing.

*c. Broken T-slot.*—A broken T-slot will fail to extract the empty case from the chamber and will usually scar the rim of the case. This stoppage is remedied by replacing the bolt.

*d. Broken barrel extension.*—The bolt will not go home and the gun will generally stop firing. In rare cases the gun will fire a few rounds with a broken barrel extension. This stoppage is remedied by disassembling the gun and replacing the broken part.

*e. Uncontrolled automatic fire.*—Uncontrolled automatic fire is the continuation of fire when the trigger or sear mechanism is released. If the cause is present before the gun is fired, it will commence the moment the bolt is home the second time during the loading; or if the defect occurs during firing, the gun will not stop firing when the trigger or sear mechanism is released.

(1) *Cause.*—The forward end of the trigger bar sprung downward, or the beveled surfaces of the trigger bar and sear burred.

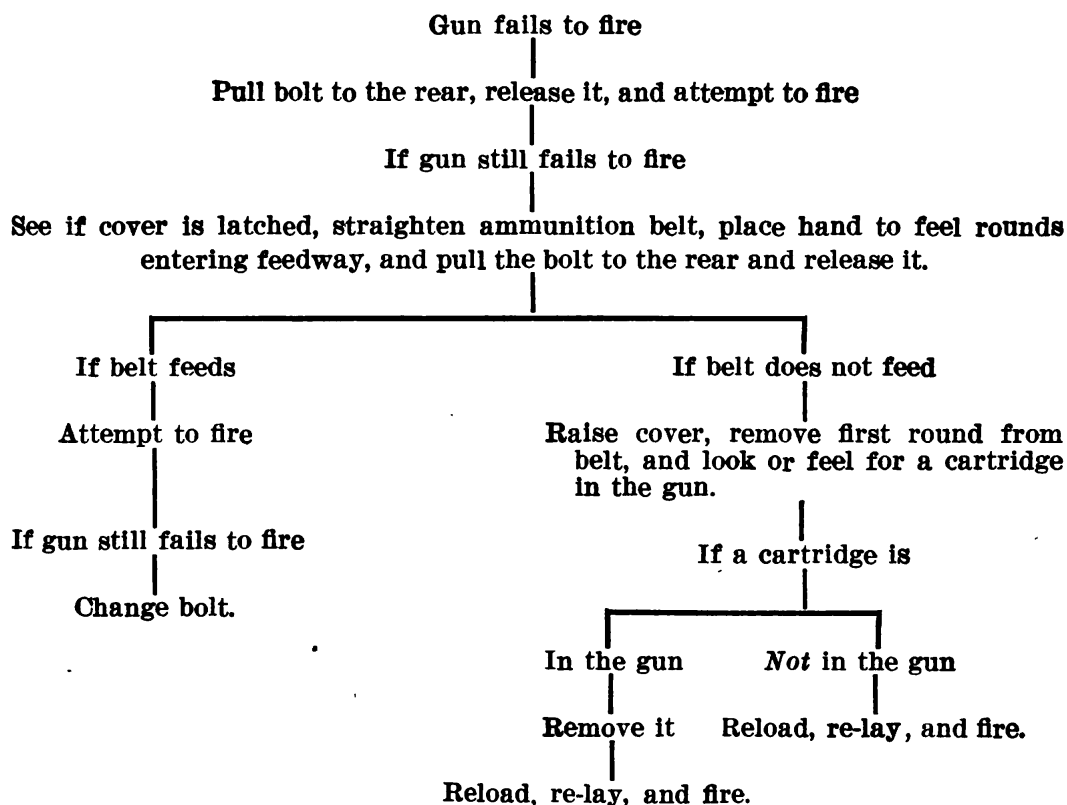
(2) *To remedy.*—(a) Keep gun directed on target.

(b) Unlatch cover.

(c) Unload and disassemble gun. Replace broken, worn, or burred parts.

*f. Tight packing.*—Too tight packing will result in sluggish operation and stoppages. Muzzle packing is more likely to cause trouble than breech packing.

*g. Immediate action.*—When a stoppage occurs during firing, the immediate action in the diagram below, or such portions as are required to reduce the stoppage, will be performed.

*Table of immediate action*

**NOTE.**—If application of the procedure does not remedy the stoppage, the gunner must examine the feed mechanism and other parts of the gun in order to locate and remedy the trouble.

## SECTION VI

## CARE AND PRESERVATION

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**48. General.**—Cannon become less copper fouled when properly cared for. It is known that the wear does not depend entirely upon the rounds fired, but very much upon the care given to the bore, such as cooling the gun between rounds, cleaning, and lubricating. When the gun is to be idle for more than a day, the bore, breech mechanism,

and bright unpainted surfaces should be cleaned with solvent, dry-cleaning, and the surfaces coated with compound, rust-preventive, light. Proper care must be given accessories and tools so that their life and use will be extended.

**49. Lubrication instructions for using arms.**—*a. Wheel bearings.*—To clean and pack wheel bearings properly, they must be removed from the hub. Follow the procedure below:

(1) Remove the bearings from the hub and wash them in solvent, dry-cleaning, until all the old grease is removed.

(2) Lay them aside to dry and wash the inside of the hub and the spindle with solvent.

(3) When bearings are thoroughly dry, pack the races with grease, wheel bearing, and reassemble in hub. Do not apply any grease to the inside of the hub or on the spindle. The grease in the bearing races is sufficient to provide lubrication until the next service period. An excess may result in leakage of the lubricant into the brake drum.

(4) Mount the wheel on the spindle and tighten the nut on the end of the spindle until there is a slight drag when the wheel is rotated.

(5) Back off the nut until the wheel turns freely (one-half turn is usually sufficient) and insert cotter pin.

(6) Install hub cap. The cap must be free of grease.

*b. Elevating rack.*—The teeth of the elevating rack and pinion require little lubrication, but as a protection against rust they must be covered with a thin coat of oil. Dust and grit will adhere to this oily film, consequently the teeth must be thoroughly cleaned and fresh oil applied before elevating or traversing the gun; otherwise, the grit will cause rapid wear of both rack and pinion. If considerable dust is present when gun is operated, the oil should be removed from the teeth and they should remain dry until action is over. If the surfaces are dry, there is less wear than when coated with a lubricant contaminated with grit.

*c. Bogie buffer cylinders and outrigger turnbuckles.*—Since there is no vent in the bogie buffer cylinders or the outrigger turnbuckles, overfilling is certain to occur. If the interior is filled with grease, there is no room for movement of the parts inclosed. Therefore, if the unit fails to function after lubrication, remove the fitting and operate the unit sufficiently to force out excess grease.

*d. Lubrication guide.*—Lubrication instructions for all points to be serviced by the using arm are shown in the Lubrication Guide (figs. 47 and 48), which specifies the types of lubricants required and the intervals at which they are to be applied. Supplementary instructions appear in the notes. These guides are to be used for the M3



and M3E1 carriage and for the M3A1 carriage only where applicable. Lubrication guide (Chek-Chart) No. 60, which will be issued for the M3A1 carriage, is not available at this printing.

*e. Points to be lubricated by ordnance maintenance personnel at time of ordnance inspection.*—(1) *Traversing and elevating gear housing.*—Lubricate these units with grease, O. D., No. 00, where continued temperatures below +32° F. are expected, and grease, O. D., No. 0, where temperatures above +32° F. prevail. In most localities this will necessitate a change of lubricant twice yearly. When changing from one grade to another it is essential that the old lubricant be thoroughly removed from the housing and inclosed parts. This will necessitate total or partial disassembly. It is impossible to dilute the lubricant to the point where it will drain through the small drain plug opening. New lubricant should be applied by removing the cover plate when possible. Apply grease through a fitting, and do not fill the housing to a point above the level testing plug.

(2) *Traversing rack and carriage ball bearings.*—Although the traversing rack and carriage ball bearings are inclosed, dirt and water contaminating the lubricant leave deposits that must be removed. To avoid damage, the parts must be disassembled and cleaned once yearly.

*f. Reports and records.*—(1) *Reports.*—If lubrication instructions are closely followed, proper lubricants used, and satisfactory results are not obtained, a report will be made to the ordnance officer responsible for the maintenance of the matériel.

(2) *Records.*—A complete record of lubrication servicing will be kept for the matériel.

**50. Gun.**—The trunnion block should be kept covered to prevent dust and grit from getting into the mechanism, causing wear and impeding smooth operation. The breech assembly should be removed and disassembled before every firing period and the parts washed with solvent, dry-cleaning. Wipe dry and coat with the prescribed lubricating oil. If the breech mechanism does not operate smoothly, it should be disassembled and the cause determined. In assembling and disassembling any part of the gun do not use a steel hammer directly on any part. A copper hammer or a wooden block should be used to transmit the blow to prevent deforming the part. Special care must be taken to insure that any sand, grit, or other foreign matter is removed from the threads of the tube as well as from the threads of the tube extension before assembling the tube to the tube extension. Failure to observe this instruction will result in the threads being badly burred or torn. The motion of the lock frame should be smooth and free. There should be no sign or evidence of dirt or grit in the

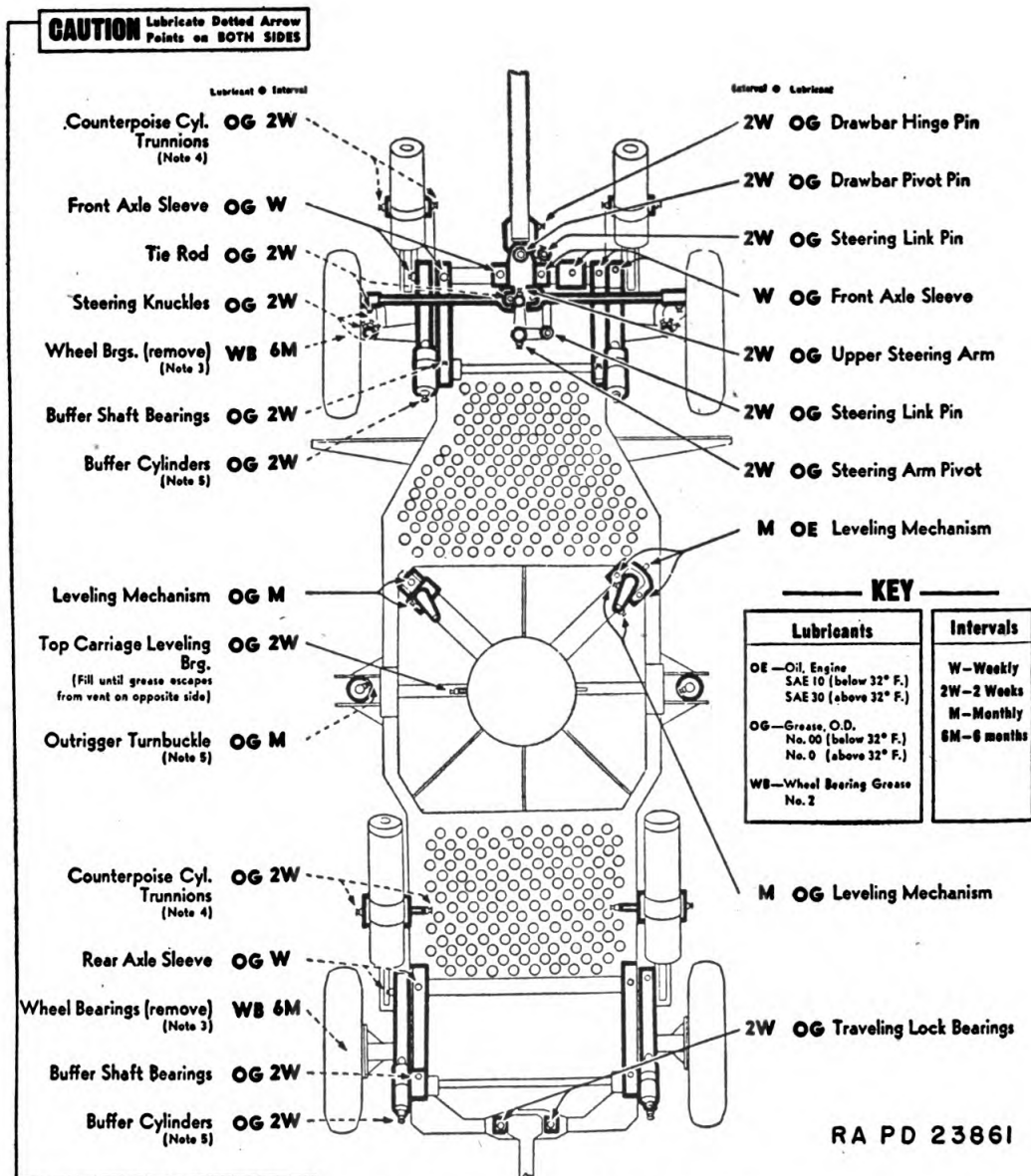


FIGURE 47.—Lubrication guide for chassis.

**NOTES.**—Additional lubrication and service instructions on individual units and parts.

1. *Intervals.*—Those indicated are for normal service. For extreme conditions of heat, water, dust, etc., lubricate more frequently.

2. *Fittings.*—Clean before applying lubricant. **Caution:** Lubricate center bearing trunnion bearings and foot firing-pedal shaft after washing gun.

3. *Elevating rack.*—Clean and apply OE daily.

4. *Breech and firing mechanism.*—Clean and oil all moving parts and exposed metal surfaces with OE daily. To avoid misfiring below freezing, remove block. Dip block in solvent, dry-cleaning. Operate firing pin in solvent, lubricate with MO, and replace mechanism.

5. *Gun bore.*—Clean and coat with OE after firing. Inspect daily and oil if necessary.

6. *Points requiring no lubrication.*—Sighting mechanism drive cables.

7. *Points to be lubricated by ordnance maintenance personnel at time of ordnance inspection.*—Traversing and elevating gear cases.

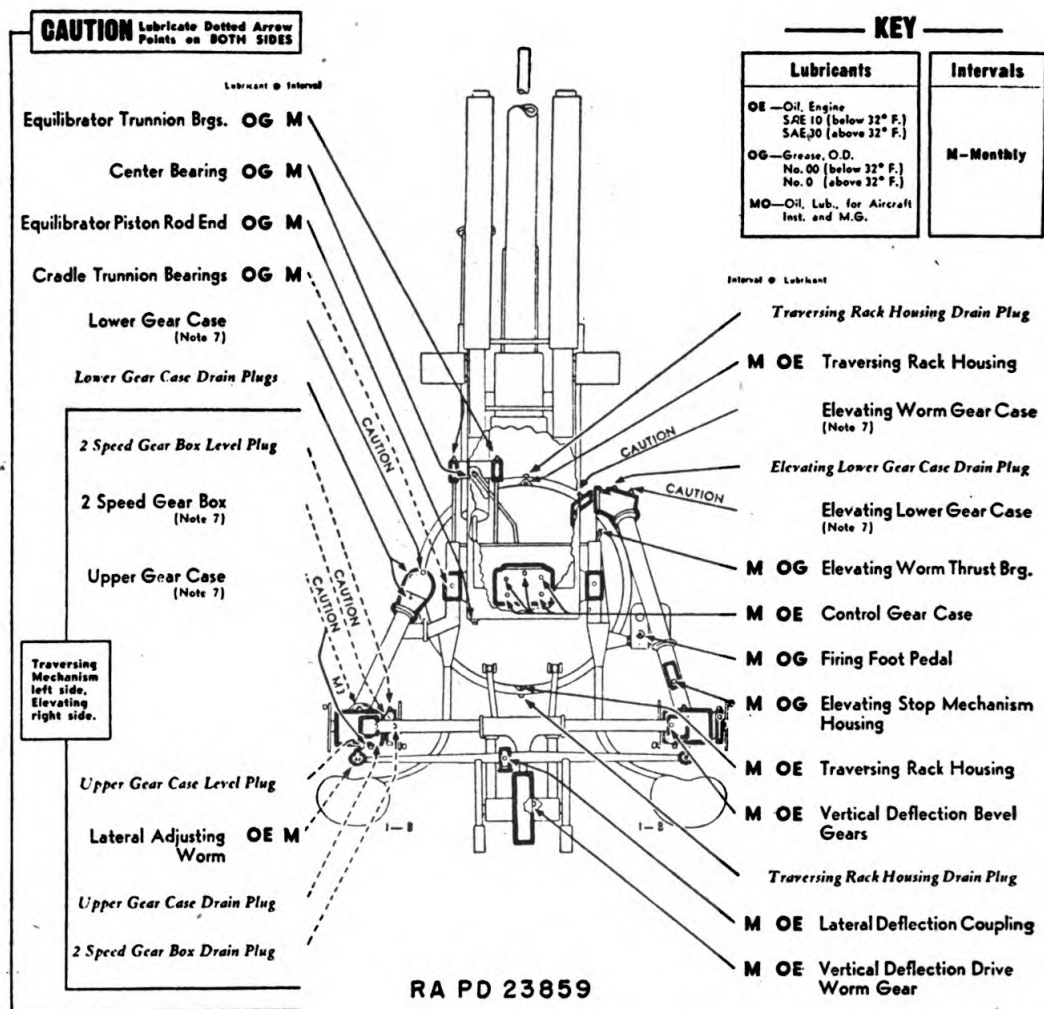


FIGURE 48.—Lubrication guide for top carriage.



**NOTES.**—Additional lubrication and service instructions on individual units and parts.

1. *Intervals.*—Those indicated are for normal service. For extreme conditions of speed, heat, water, mud, snow, rough roads, dust, etc., lubricate more frequently.

2. *Fittings.*—Clean before applying lubricant. **Caution:** Always lubricate chassis lubrication points after washing.

3. *Wheel bearings.*—Remove wheel, clean, and repack bearings only.

4. *Counterpoise cylinders.*—Remove cap on outer end of cylinder and coat the surface above piston with OG monthly.

5. *Buffer cylinders and outrigger turnbuckles.*—**Caution:** Excessive grease in units will cause malfunction. If overfilled, remove grease fitting and operate parts to force out excessive grease.

6. *Oil can points.*—Lubricate buffer adjustment linkage and hand levers with OE weekly.

slideways or operating cams of the lock frame. Likewise, the slideways of the tube extension should be kept clean and smooth. Before firing, the bore should be thoroughly wiped out to insure that it is clean and dry. At the end of each period of firing the bore should be thoroughly washed out and the gun depressed to the horizontal position. It should then be dried and well oiled when cool. When not actually in use guns should have their covers in position.

**51. Recuperator mechanism.**—*a. Recuperator piston rod nut.*—This nut should be screwed on the recuperator piston rod so that the nut seats solidly on the shoulder of the tube extension and the flat on the nut is in line with the top surface of the breechblock stop. This latter provision is necessary to prevent the nut from shaking loose on the piston rod.

*b. Recuperator springs.*—(1) At high elevations the recuperator spring must lift the weights of the tube, the tube extension, and the piston and piston rod, in addition to forcing the oil past the piston. It has very little power in excess of that required for these functions. The use of recoil oil of improper viscosity or the development of undue friction, due to dirt, old grease, or improper lubricants, may cause the gun to fail to return completely into battery. If this failure does not exceed one-eighth inch, the gun will fire safely. When the lock frame is more than one-eighth inch out of battery, the breechblock cannot close and the gun will not fire.

(2) Great care should be exercised in maintaining the correct amount of oil in the mechanism. With too little oil it is possible to have excess recoil to the extent that the recuperator piston drives against a solid column of compressed spring, which will ruin the piston.

(3) There is no adjustment provided for the packing in the rear end of the cylinder. The development of excess leakage should be reported to ordnance personnel.

*c. Addition of recoil oil.*—(1) Use only oil, recoil, light, from containers that have not been previously opened.

(2) Elevate the gun to 5°.

(3) Remove the recuperator filler screw and the expansion tube relief screw (fig. 1).

(4) Add oil, recoil, light, until just visible in the bottom of the recess in the bottom of the filling hole. Slap the outside walls of the recuperator cylinder with the bare hands while adding the oil. This action will force the escape of any air trapped in the cylinder. Continue adding oil and jarring the cylinder until all air is removed and the oil remains stationary at the bottom of the filling hole when the cylinder is slapped.

(5) Replace the recuperator filler screw and then the expansion tube relief screw.

(6) If too much oil has been added, depress the gun slightly and remove the excess oil.

**52. Driving spring assemblies.**—*a. Care.*—(1) No adjustments are provided for the driving spring. Dents in the cylinders or bent rods may cause the gun to fail. Also, failure may result from accidental sealing of the vents in the forward ends of the cylinders with heavy grease or mud.

(2) A critical point in the operation occurs when the forward movement of the lock frame ceases and the breechblock is forced into firing position. At this point the driving springs cease to function and give over to the small operating lever spring in the lock frame itself. Dirt in the cam slots, burs on the breechblock, dirt or grit on the lock frame or its track, weak driving springs, or a weak operating lever spring may result in a failure of the breechblock to close.

*b. Fastening.*—It is important that the fastenings of the driving spring assemblies to the tube extension and lock frame be safe and secure at all times.

**53. Feed box assembly.**—The many parts of the feed box assembly must be kept clean and free from dirt, grit, and moisture. If any one of these parts should bind, the entire mechanism will jam. All studs, pivoting parts, holes, and plungers must be kept clean, properly lubricated, and free from dents and burs. Cotter pins should always be bent close to their pins or nuts so that no projecting parts will interfere with the motions of the mechanisms.

**54. Carriage.**—The carriage cannot be kept in serviceable condition unless proper attention is given to cleaning, lubrication, and loose or broken parts. Bearing surfaces, revolving parts, springs, screw threads, gear teeth, and exterior parts must be clean and free from dirt. Special attention should be given to exposed teeth and bearing surfaces. In disassembling and assembling, precautions must be taken to prevent the entrance of foreign matter. A general inspection is required before and after use. If the carriage is to be unused for a considerable length of time, bright unpainted surfaces should be cleaned with solvent, dry-cleaning, and coated with a rust-preventive compound. All lubricating fittings should be kept clean, and, if necessary, a piece of wire may be used in cleaning out passages. Every precaution should be taken by the using service to make certain that the battery used to actuate the electric brakes when the carriage breaks away from the prime mover is in place, properly up to charge, and that all wiring and switches are functioning correctly. The break-

away switch is to be left habitually in the "off" position, except when the brakes are tested by authorized personnel. Proper functioning of brakes is to be tested before each trip. Switch terminals should be well wrapped and the safety chain to the safety switch should under no circumstances be wrapped around the switch. To obtain maximum mileage, the tires should be checked frequently to see that they contain the proper air pressure. The wheels should not be washed with the tires deflated. Remove any foreign substances from the rubber. It is recommended that the carriage should not be towed at rapid speeds over rough terrain.

**55. Counterpoise cylinders.**—The spring mechanisms of these cylinders should allow the carriage to descend to the ground freely and slowly without having to use much force on the carriage or the counterpoise cylinder levers. Excessive force should not be exerted on the counterpoise levers, as damage is likely to occur to the mechanism. It should be possible to raise the carriage from the ground without excessive force. Adjust tension of counterpoise cylinder springs as described in paragraph 60.

**56. Care and cleaning of cal. .50 machine gun.**—*a. Cleaning bore.*—(1) Disassemble groups from gun.

(2) Place barrel, muzzle down, in a vessel containing hot water and issue soap, a soda ash solution, or, lacking these, hot water alone.

(3) Insert cleaning rod with a flannel patch assembled in the breech. Move rod forward and back for about 1 minute, pumping water in and out of bore.

(4) Use a brass or bronze wire brush while the bore is wet, running it forward and back through the barrel three or four times.

(5) Pump water through bore again to clean.

(6) Dry the cleaning rod and remove barrel from water. Using dry, clean flannel patches, thoroughly swab bore until it is perfectly dry and clean. Thoroughly dry and clean the chamber, using a flannel patch on a stick if necessary.

(7) Saturate a patch with oil, lubricating, preservative, light, and swab bore and chamber with the patch. Allow a thin coat of the oil to remain in the bore.

(8) Guns should be cleaned not later than the evening of the day on which they are fired, preferably immediately after cessation of firing.

(9) Inspect and clean the guns for 3 days following cessation of firing.

*b. Cleaning parts other than bore.*—(1) Wipe receiver clean, care being taken to remove dirt from belt holding pawl. Thoroughly clean



cover, bolt, barrel extension, oil buffer, and back plate, using a small stick covered with a flannel patch to remove dirt from all recesses.

(2) Wipe all parts with an oily rag.

(3) The gun should be examined to see if the barrel packing is in good condition.

**57. Filling oil buffer of cal. .50 machine gun.**—Remove the oil buffer tube filling screws from the base of the buffer tube. Use the oil buffer filling oiler filled with oil, lubricating, for aircraft instruments and machine guns. Start the flow of oil by pressing on the base of the oiler. While the oil continues to pour from the oiler, insert nozzle into either filling hole and with a continued pressure on the base of the oiler allow oil to flow into the buffer tube. *Do not release pressure on oiler until nozzle has been removed from filling hole, thus avoiding getting air bubbles into the buffer tube.* Repeat the operation until the buffer is overflowing. Replace the filling screws. Any excess oil in the buffer will be relieved by the relief valve in the forward end of the buffer body. The reason that two filling holes are provided is to show visually by overflow when the buffer tube is completely full.

## SECTION VII

### INSPECTION AND ADJUSTMENT

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**58. General.**—*a.* Inspection is for the purpose of determining the condition of the matériel, whether repairs or adjustments are required, and the remedies necessary to insure serviceability and proper functioning. Check to see that a record of all inspection and maintenance is kept in the Artillery Gun Book, O. O. Form 5825. Instructions for the use of the gun book are outlined in its introductory pages.

*b.* Inspection of the gun and carriage normally should be carried out during all procedures necessary for operating the gun and carriages. Each time the carriage is emplaced the operators should carefully observe all of the mechanisms, together with the levers and handles which are necessary for their operation. If mechanisms gradually become more difficult to operate, thereby showing signs of a gradual wear or gradual deformation of parts, this should be carefully noted for a critical inspection and possible disassembly as soon as practicable.

Inspection of the gun should be carried on at all times that the gun is being handled, either under actual firing conditions or during cleaning and lubricating procedures. When firing, the action and behavior of the gun should be noted. When disassembling, for the purpose of cleaning and lubrication, each and every part should be checked for burs, rough surfaces, or any other signs of wear that will disturb the true motion of the mechanisms. These deformations should be removed immediately by using a fine abrasive. After lubrication and cleaning these parts should be checked for their proper action. With this type of inspection no further inspections will be necessary unless the gun is to be stored. Normally the gun should be disassembled for cleaning, lubrication, and inspection immediately after firing. The gun shall be kept in this condition and ready for firing unless put away for storage and then proper methods for storage will be used. Before firing it will be necessary for the operators to ascertain that the gun and carriage are in perfect working condition. Proper coordination of cleaning, lubrication, inspection, correction, and operating procedures will keep the matériel in perfect working condition at all times and prevent malfunctioning at critical moments.

c. The following paragraphs are to be used as an outline for inspection and corrections during daily cleaning and firing operations.

#### 59. Gun.

Inspection	Correction
<p>a. <i>Gun tube</i>.—Note general appearance and smoothness of screwing the tube into the tube extension. Examine the bore. Note its condition for copper deposits on the lands and in the grooves, erosion at origin of rifling, and wear of the firing chamber. Examine the outer portion of the gun tube for erosion at the point of entry into the trunnion block. Note condition of the tube threads.</p> <p>b. <i>Back plate</i>.—(1) Remove back plate assembly and see that the latch functions properly. The buffer plunger stop screw should be securely tightened so that the parts will not vibrate loose during firing.</p> <p>(2) Disassemble and inspect the plunger and pieces for rough surfaces or burs.</p>	<p>a. Smooth down all burs and abrasions with a fine abrasive such as crocus cloth. Smooth damages on the threads of the gun tube or tube extension. If the gun tube does not seat firmly in its socket, the trunnion block bushing or the tube threads might be excessively worn. If these parts cannot be smoothed down to fit properly, one or the other or all the parts must be replaced.</p> <p>b. (1) Replace back plate latch body if worn or the spring if the latch is loose.</p> <p>(2) Smooth the rough portions of the internal parts with a fine abrasive.</p>

Inspection	Correction
<p>(3) Note that the internal parts are properly lubricated.</p> <p>(4) Note back plate assembly for excessive shock during firing.</p>	<p>(3) Lubricate before assembly.</p> <p>(4) Buffer adjusting screw (fig. 56) either too tight or too loose. If too loose, the lock frame will cause the buffer plunger to strike the rear wall. If too tight, the lock frame will strike the plunger without the shock being absorbed. Adjust the buffer adjusting screw to give smoother action.</p>
<p><i>c. Feed box.</i>—Open the feed box cover and note that all parts of the mechanism are in place, properly secured, and properly lubricated. There should be no burs, grit, nor other signs of uncleanness or wear. Be sure that no parts are missing.</p>	<p><i>c.</i> Replace missing or badly damaged parts. Smooth all rough portions.</p>
<p><i>d. Breechblock.</i>—(1) Remove the breechblock and note whether there are scores or bruises on any of the surfaces.</p> <p>(2) Depress back of firing pin to check the action of the firing pin spring. The firing pin and bushing should not protrude in front of the breechblock face when pressure is released.</p>	<p><i>d.</i> (1) Smooth all rough sliding surfaces of the breechblock.</p> <p>(2) Replace the firing pin if it is worn or bent and replace the spring if it does not return the firing pin into the breechblock body as soon as pressure is released.</p>
<p><i>e. Driving spring assembly.</i>—(1) Raise the carrier until caught by the carrier catch and retract the lock frame until it is caught by the carrier dog. Release the carrier catch, thereby allowing the lock frame to charge forward. The driving spring assemblies should pull the lock frame forward with sufficient force to load a round into the firing chamber and to close the breechblock completely.</p>	<p><i>e.</i> (1) If the driving springs appear to be weak remove the driving spring assemblies for thorough cleaning as follows: Place the forward end in a quantity of solvent, dry-cleaning, and using the rod as a pump plunger draw solvent through the small hole in the forward end of the cover. Try to remove all possible gummy or heavy lubricant in this manner. Do not clog the hole nor bend the rod. After cleaning, flush with oil, engine. If this cleaning does not improve the action of the driving spring assemblies, check all the camways and slideways of the lock frame assembly. If these are in good condition replace the driving spring assemblies.</p>
<p>(2) Ascertain that the lock frame moves back without any signs of grit or burs in its slideways.</p>	<p>(2) Clean lock frame slideways, remove burs, and lubricate.</p>

Inspection	Correction
<p><i>f. Recuperator mechanism.</i>—(1) Elevate the gun to 5°. Remove the recuperator filler screw and the expansion tube relief screw and note whether the recoil oil is at the proper level.</p> <p>(2) Measure the length of recoil as follows:</p> <p>(a) Put a film of grease on the tube for 12 or more inches forward from the trunnion block bushing.</p> <p>(b) Fire one or more rounds.</p> <p>(c) Measure the distance that the grease has been pushed forward by the bushing.</p> <p>(d) This distance is the length of recoil. When the recuperator is warmed up, this length should be 10¾ inches.</p> <p>(3) Examine the back portion of the recuperator cylinder for signs of excessive leakage. Examine all other portions of the recuperator cylinder</p>	<p><i>f.</i> (1) Adjust recoil oil to proper level as described in paragraph 51c.</p> <p>(2) (a) If length of recoil is too great, elevate the muzzle to more than 5° and add a few additional drops of oil.</p> <p>(b) If length of recoil is too small, depress the gun to less than 5° and remove a few drops of oil.</p> <p>(c) Recheck length of recoil by firing another round.</p> <p>(3) Excessive leakage of the recuperator mechanism or improper action of the mechanism when every other part of the gun is in proper working condition</p>

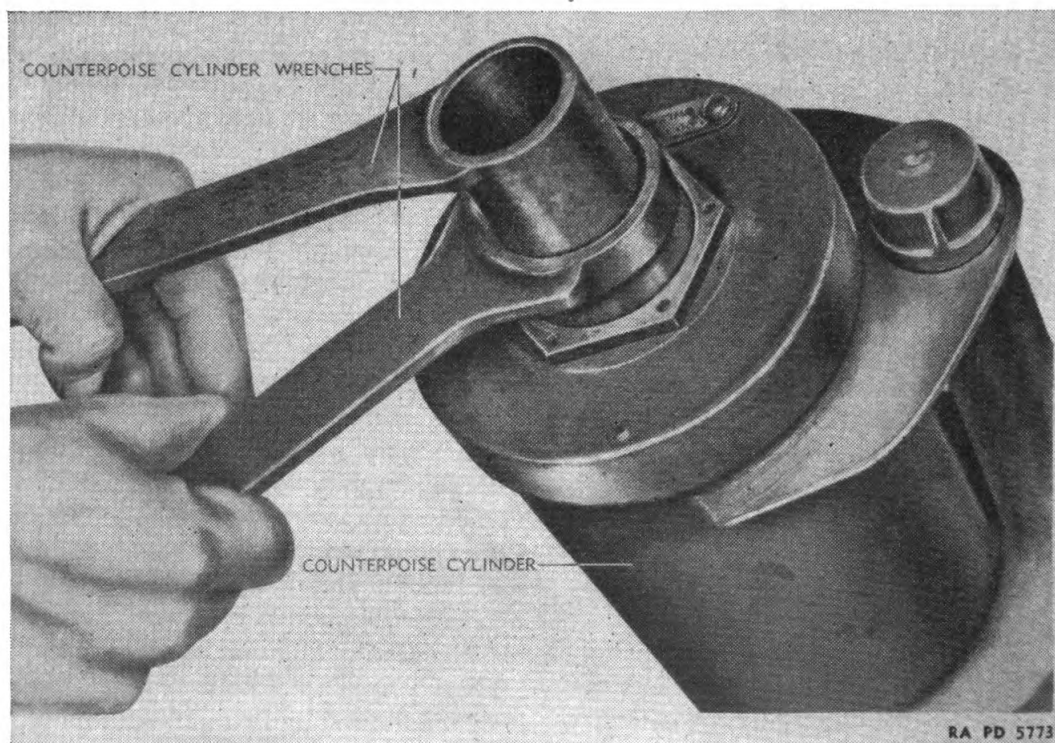


FIGURE 49.—Adjustment of counterpoise spring.



Inspection	Correction
<p>for leakage. Note the action of the recuperator when firing the gun, taking special note when the gun is elevated to a high position.</p> <p><i>g. Cartridge tray.</i>—Trays are not completely interchangeable, especially on lower numbered guns. Each tray was fitted to its gun and the gun number stamped on the center of the underside of the tray. Numbered trays should be kept with correspondingly numbered guns.</p>	<p>should be reported to ordnance maintenance personnel.</p> <p><i>g. If trays do not properly fit the feed box brackets, the tray should be refitted and renumbered by ordnance mechanics.</i></p>

## 60. Carriages.

Inspection	Correction
<p><i>a. General.</i>—(1) Check for general appearance. Note whether carriage is properly painted and whether lubrication fittings have a red circle painted around them.</p> <p>(2) Examine the chassis and firing platform for bent, damaged, or broken plates, and for cracked welds.</p> <p><i>b. Counterpoise cylinders.</i>—Lower and raise the chassis as described under operation. No excessive force should be necessary in carrying out these instructions. One man should be able to raise and lower each corner of the carriage.</p>	<p><i>a. (1) Clean and paint all exposed metal that originally had paint.</i></p> <p>(2) Broken or malformed parts of the chassis must be repaired by ordnance maintenance personnel.</p> <p><i>b. If it is difficult to raise or lower the carriage, adjustment of the counterpoise cylinder springs will be necessary. Adjust only the cylinder whose wheel is difficult to operate. Adjustment is as follows (fig. 49):</i></p> <p>(1) Raise the carriage to traveling position.</p> <p>2 Remove the upper cap of the counterpoise cylinder.</p> <p>(3) Place the larger counterpoise cylinder wrench over the larger nut. Place the smaller counterpoise cylinder wrench in the larger wrench and over the smaller nut.</p> <p>(4) Loosen the smaller nut.</p> <p>(5) If the carriage is hard to lower, loosen the larger nut by turning it counterclockwise. If the carriage is hard to raise, turn the larger nut clockwise.</p>

Inspection	Correction
<p><i>c. Elevating mechanism.</i>—(1) Check for binding or excessive backlash.</p> <p>(2) Elevate and depress the gun on the M3 and M3E1 carriage manually and note smoothness of operation.</p> <p>(3) Elevate and depress the gun and cradle of the M3A1 carriage by hand crank and also by remote control system. There should be neither binding nor backlash with either type of operation.</p> <p><i>d. Traversing mechanism.</i>—Check for excessive backlash or binding. Traverse 360° manually and note smoothness of action. Operate the M3A1 carriage by hand crank and also by remote control system. There should be no binding or backlash by either type of operation.</p>	<p>(6) Tighten the smaller nut after the adjustment.</p> <p>(7) Test the mechanism for improved action.</p> <p>(8) Replace the upper cap.</p> <p><i>c.</i> (1) If handwheel or crank play is greater than one-fourth turn, notify ordnance maintenance personnel.</p> <p>(2) If load on the handwheel is excessive, adjustment of the equilibrator is necessary as follows:</p> <p>(a) Set the gun to maximum elevation.</p> <p>(b) Remove the front cap of the equilibrator.</p> <p>(c) Place the larger equilibrator cylinder wrench over the larger nut and the smaller equilibrator cylinder wrench in the larger one and over the smaller nut in the manner shown in figure 49.</p> <p>(d) Loosen the smaller nut.</p> <p>(e) If the gun is hard to elevate, turn larger nut clockwise. If the gun is hard to depress, turn the larger nut counter-clockwise.</p> <p>(f) Tighten the smaller nut after the adjustment.</p> <p>(g) Test the mechanism for improved action.</p> <p>(h) Replace the front cap. If the above adjustment cannot rectify the elevating handwheel load, notify ordnance maintenance personnel.</p> <p>(3) Apply same corrections as above.</p> <p><i>d.</i> If handwheel or crank play is greater than one-fourth turn or if handwheel load is excessive, notify ordnance maintenance personnel.</p>

Inspection	Correction
<p><i>e. Foot-firing mechanism.</i>—(1) Check the foot-firing pedal of M3 and M3E1 carriage for operation of the latch lever. This should engage the pedal when pressure on the pedal is released.</p> <p>(2) Cock the firing hammer by pulling the lock frame to the rear several inches and then allow to spring forward so that the breechblock is completely closed. Depress the foot pedal and note that the trigger is tripped. This should be evidenced by a sharp click in the gun.</p> <p>(3) Inspect the action of the front and rear cable pedals of the M3A1 carriage in the same manner.</p> <p>(4) Check the operation of the mechanism change lever of the M3A1 carriage. When this lever is turned to the far right the gun trigger should remain pulled when the pedals are depressed. When the mechanism change lever is turned to the far left the trigger should be depressed and then snapped back to its original position each time the pedal is depressed.</p> <p>(5) Ascertain that there is no binding of the foot-firing cables of the M3A1 carriage.</p>	<p><i>e.</i> (1) Ream out the socket of the foot pedal latch or smooth down the latch plunger to provide a positive engagement of the plunger in the socket. Check lubrication.</p> <p>(2) If the hammer is not tripped, examine the linkage system for binding parts. Lubricate freely with oil, engine. The motion of the foot pedal can be adjusted by means of the foot firing adjusting nut (fig. 32).</p> <p>(3) Motion of the front cable pedal can be adjusted by means of the cable adjusting screw (fig. 33). Motion of the rear cable pedal is adjusted by means of a screw and lock nut which are secured to the underside of the firing platform directly below the rear cable pedal.</p> <p>(4) Notify ordnance maintenance personnel of a malfunction of the mechanism change lever.</p> <p>(5) Lubricate and see that there are no kinks in the cables. Cables that are badly kinked or that bind must be replaced.</p>
<p><i>f. Buffer mechanisms.</i>—(1) While traveling note whether the buffer mechanisms are taking up the road shock. The buffer pins should bear against the axle arms.</p> <p>(2) Ascertain that the buffer lever lock functions properly and will not shake out of place.</p>	<p><i>f.</i> (1) If the axle arms are worn at the point of contact with the buffer rods, report to ordnance maintenance personnel. A small adjustment of the buffer rods is possible by turning the locking nut and retaining nut on the top of the buffer rod. The total available adjustment is about 1 inch.</p> <p>(2) If the lock does not function properly, report to ordnance maintenance personnel.</p>

Inspection	Correction
<p><i>g. Safety switch.</i>—(1) Travel slowly and pull the safety switch chain. Note whether the carriage comes to a sudden stop. Set the safety switch to the "off" position after this test.</p> <p>(2) Note position of safety switch chain.</p> <p><i>h. Leveling mechanism.</i>—Revolve the handwheels or ratchet wrenches of the leveling mechanism. Note the effect on the leveling vials. The leveling mechanism should rotate through its entire range without binding or backlash. Ascertain that once the carriage is leveled it will remain so while traversed through 360°.</p> <p><i>i. Outrigger assemblies.</i>—Ascertain that the outrigger turnbuckles will hold the outriggers in position without any possibility of looseness or damage to the parts. The outriggers should remain firm and secure in traveling and in firing positions.</p> <p><i>j. Cradle.</i>—(1) Inspect the elevating rack for uniformity and wear of the teeth.</p> <p>(2) Inspect the mounting of the gun in the cradle. There should be no looseness.</p> <p>(3) Inspect mounting of cradle to top carriage.</p> <p>(4) Check the mounting of the caliber .50 machine gun on the cradle of the M3E1 carriage. These guns should be held securely in place.</p> <p>(5) Check the cradle shield cover and cradle shield slide to see that they are on the M3A1 carriage and that they can be removed readily.</p>	<p><i>g.</i> (1) If the carriage does not stop, replace battery in the carriage. If this does not help, notify ordnance maintenance personnel.</p> <p>(2) The chain should under no circumstances be wrapped around the switch box.</p> <p><i>h.</i> Report any malfunction to ordnance maintenance personnel.</p> <p><i>i.</i> Report any malfunction to ordnance maintenance personnel.</p> <p><i>j.</i> (1) Report wear or broken teeth to ordnance maintenance personnel.</p> <p>(2) Tighten gun mounting keys. If the slideways or gun mounting lugs are worn, report to ordnance maintenance personnel.</p> <p>(3) There must be no looseness of the cradle trunnions or evidence of binding of the trunnion bearings. Report any such malfunctions to ordnance maintenance personnel.</p> <p>(4) Tighten mounting screws.</p> <p>(5) Straighten bent portions. Replace if badly damaged.</p>



**61. Brakes.**

Inspection	Correction
<p>(a) <i>Measurement of current to each brake</i> (to be carried out monthly):</p> <p>(1) Ascertain that a 6-volt electric system is connected to the brake system.</p> <p>(2) Remove one lead wire of a brake cable from a brake terminal and connect the ammeter (for electric brake) in series between the wire and brake terminal.</p> <p>(3) Apply the controller full on. Read the ammeter.</p> <p>(4) Repeat on the other brakes.</p> <p>(5) The lever type of brakes should give a reading of 2.2 amperes and the disc type of brakes should give a reading of 2.6 amperes.</p> <p>(6) Variations between the reading of the brakes on any one carriage should not exceed 0.1 amperes.</p> <p>b. <i>Measurement of current to each controller</i> (to be carried out monthly):</p> <p>(1) Disconnect battery lead-in wire at the controller and place the ammeter between the lead-in wire and the controller.</p> <p>(2) Set the controller to full on position and read the ammeter.</p> <p>(3) Remove the ammeter, reconnect the lead-in wire, and connect the ammeter in a similar manner to the other terminal of the controller. Set the controller to full on position and read the ammeter.</p> <p>c. <i>Inspection of brake linings and drums</i> (to be carried out when lubricating wheel bearings):</p> <p>(1) Remove the wheel as described in paragraph 79. Inspect the brake lining for wear.</p> <p>(2) Inspect the brake lining for presence of oil or grease.</p> <p>(3) Inspect the brake drum for scores, abrasion, rust, or noticeable irregularities in roundness.</p>	<p>(a) In case of failure to get this agreement:</p> <p>(1) Follow electric system to the coupling on the carriage for bare wires. Tape or replace bare wires.</p> <p>(2) Test the coupling cable current.</p> <p>(3) Check the prime mover coupling socket connection for corrosion.</p> <p>(4) If the fault cannot be found, refer to ordnance maintenance personnel.</p> <p>b. Change controllers if the difference in reading is greater than 0.2 amperes.</p> <p>c. (1) If the lining is worn down to the brass rivets the lining must be replaced by ordnance maintenance personnel.</p> <p>(2) Report to ordnance maintenance personnel for replacement.</p> <p>(3) Report such faults to ordnance maintenance personnel.</p>

**62. Caliber .50 machine gun.**—The following table of points to be observed before, during, and after firing will be found convenient as a guide for the proper care of the gun at all times. It will also serve as a guide for the inspection of the gun.

	Before	During	During temporary cessation	After
Bore.....	Look through and clean.	.....	Clean bore.....	Clean and oil.
Muzzle gland.....	Pack and tighten.	.....	Examine and tighten if required.	Examine and repack if required.
Moving parts.....	Oil and test for worn or broken parts. See that parts function without excessive friction.	Keep oiled.....	Inspect and oil; clean dirt from belt holding pawl.	Remove bolt, oil buffer, barrel extension, and barrel; clean, oil, replace, and release firing pin.
Head space.....	Make correct adjustment and test.	Tighten if several separated cases occur.	.....	Adjust correctly and test. Examine barrel locking spring.
Packing.....	Examine for leakage or excessive friction.	Watch for leakage.....	Examine for leakage.....	Examine and replace if necessary.
Rear sight and wind gage.....	Clean and free from grease. See that sight is in good mechanical condition. Set sight at 700, wind gage at 0.	Keep properly set.....	Keep properly set.....	Clean and oil. Set sight at 700 and wind gage at 0.
Water.....	Fill water jacket, see that water plugs and hose connections are tight and and that there is a sufficient supply of water. <sup>1</sup>	Keep water jacket full and plugs and hose connections tight.	Keep water jacket full and plugs and hose connections tight.	Empty all water into box. Wash out or flush water jacket if muddy or dirty water has been used.
Belts and ammunition.....	See that belts are clean and secure sufficient supply of ammunition. Inspect ammunition.	Keep belt in line with feed opening.	Replace belt with full one if necessary.	Clean and refill all belts. Separate live rounds from empty cases. Inspect ammunition.
Oil.....	See that the oil can is full.	.....	Refill oil can.....	Refill oil can.
Spare parts and tools.....	Keep clean and oiled. See that kits are complete.	Keep within reach.....	Make repairs. Replace broken or worn parts.	Check, replace broken or missing parts, clean, and oil.
Gun record.....	Check from last firing to see that repairs have been made. For overhead fire see that 5,000 rounds per barrel have not been exceeded.	.....	Note performance on gun report.	Complete gun record.

<sup>1</sup> If the gun is fired without circulating unit the outlet hole in the water jacket must be left uncovered.

**63. Head space of cal. .50 machine gun.**—The head space of a military weapon with a cartridge fully seated in the chamber is the distance between the base of the cartridge and the face of the bolt. In Browning machine guns, the head space is adjusted by obtaining the proper distance between the forward part of the bolt and the rear end of the barrel. The head space adjustment must be checked before firing.

*a. Head space adjustment.*—(1) In the past the head space has been adjusted with the barrel, barrel extension, and bolt out of the gun. However, the belt adjustment is obtained with the gun fully assembled. This method has the additional advantage of avoiding the loss of the cooling liquid.

(2) To adjust the head space with the gun assembled, screw barrel into barrel extension, using the point of a cartridge until the action will just close without being forced. Then unscrew the barrel two notches.

**Caution:** Care must be exercised to avoid roughening the barrel surface during adjustment. Care must also be exercised to eliminate binding of the barrel by the packing, or a false adjustment may otherwise be obtained.

*b. Effect of head space adjustment.*—Probably the most important adjustment of the machine gun is the head space adjustment. Tests show that shot patterns are not adversely affected by the head space when the guns are adjusted as outlined above. In fact, better uniformity of shot patterns will be obtained when the guns are operated with the above adjustment, which is based on the fundamental design of the weapon. Tests have also proved that guns may be damaged and in some cases put out of action by using unapproved methods of adjusting the head space. Many reports show that difficulties with improperly guided belts and with firing mechanisms have been attributed to undue concern over head space adjustment.

(1) *Insufficient head space.*—When the head space adjustment is too tight, poor functioning will result, as the breech lock will not fully enter its recess in the bolt. This condition may damage the barrel extension, bolt, or breech lock. Extraction trouble may also occur due to improper timing of locking and unlocking. Furthermore, with a tight head space adjustment the gun operates sluggishly because of the binding of the moving parts.

(2) *Excessive head space.*—If the head space is too great, a separation of the cartridge case may occur. Should there be any weakness in the base of the cartridge case, such as a split case, the possibility of a rupture is increased by excessive head space.

*c. Use of head space and timing gage.*—Head space the gun as prescribed above. Check head space as follows: Retract the bolt slightly in order to relieve the pressure between the bolt and the end of the barrel which is caused by the driving spring. Then, insert the gage in the T-slot between the face of the bolt and the end of the barrel. If the gun is head-spaced too tightly, it will not be possible to enter the gage between the face of the bolt and the end of the barrel, and if such is the case, the barrel should be unscrewed one notch at a time from the barrel extension until the gage will enter. If the gun has been head-spaced in the manner prescribed for the particular weapon, and if the head space gage can be entered between the face of the bolt and the end of the barrel, the head space is correct. It must be clearly understood that the head space gage is a “go” gage which was designed particularly for the purpose of checking guns in installations where tight head space adjustment would cause serious trouble. However, the gage may be used to determine whether head space is unnecessarily loose by screwing the barrel into the barrel extension one notch at a time until the gage will not enter and then unscrewing the barrel one notch so that the gage will enter.

## SECTION VIII

DISASSEMBLY AND ASSEMBLY OF 37-MM AA GUN M1A2  
AND CARRIAGES

	Paragraph
Gun tube .....	64
Gun .....	65
Back plate assembly .....	66
Removal of lock frame assembly .....	67
Disassembly of lock frame assembly .....	68
Assembly and installation of lock frame .....	69
Driving spring assembly .....	70
Breechblock .....	71
Removal of tube extension .....	72
Disassembly of tube extension .....	73
Assembly and installation of tube extension .....	74
Disassembly of feed box mechanism .....	75
Assembly of feed box mechanism .....	76
Trigger and trigger bar .....	77
Removal of wheels from carriages .....	78
Removal of brake drum and wheel .....	79
Installation of brake drum and wheel .....	80
Replacement of counterpoise spring .....	81
Replacement of buffer mechanism spring .....	82
Replacement of equilibrator springs .....	83

**64. Gun tube.**—*a. Removal from gun.*—(1) Set the gun tube to a horizontal position.



(2) Raise the carrier until caught by carrier catch and pull the lock frame to the rear until caught by the carrier dog. *It is important that this be carried out in order to prevent the extractor from being damaged by the gun tube.*

(3) Place the tube support in position between the recuperator cylinder and the tube (fig. 50).

(4) Remove the trunnion block bushing retaining screws (fig. 51).

(5) Depress the tube lock depressor and turn the gun tube by means of the tube wrench (fig. 52). When the tube has been turned one-fourth of a revolution the tube lock depressor can be released and the tube should be unscrewed by hand. Withdraw the tube from the gun. The trunnion block bushing will come out with the gun tube. If the

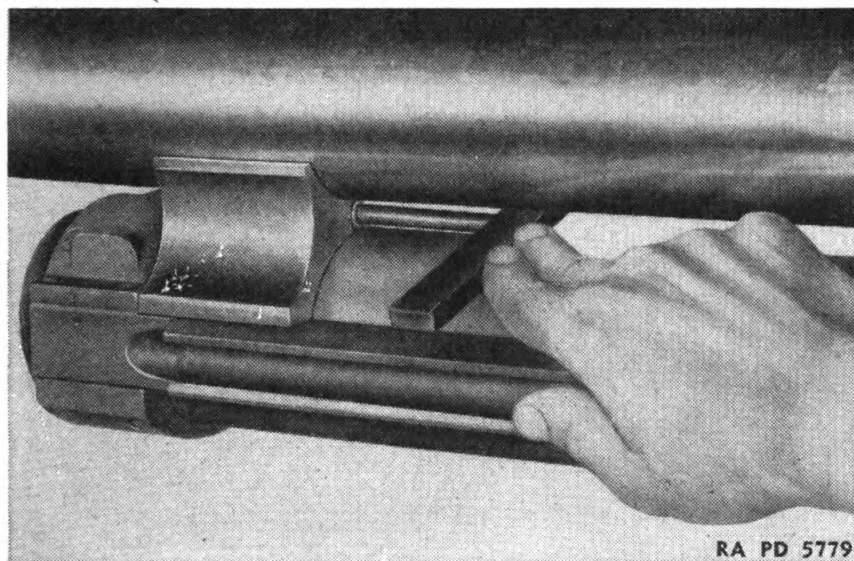


FIGURE 50.—Placing tube support for removal of gun tube.

tube sticks against the tube lock, tap the lock lightly until it is disengaged from the tube.

*b. Installation.*—(1) Set the gun approximately horizontal.

(2) Raise the carrier until caught by the carrier catch and retract the lock frame until it is caught in the rear position by the carrier dog.

(3) Place the tube support on the recuperator cylinder.

(4) Coat the threads of the tube and the portion which recoils into the trunnion block with grease, graphite, light, or oil, engine.

(5) Guide the threaded end of the tube into the trunnion block until it is pressing lightly against the threads of the tube extension and press the trunnion block bushing into place. Maintain this pressure and rotate the tube counterclockwise until a distinct click is heard, signifying that the end of the thread on the tube has passed the end



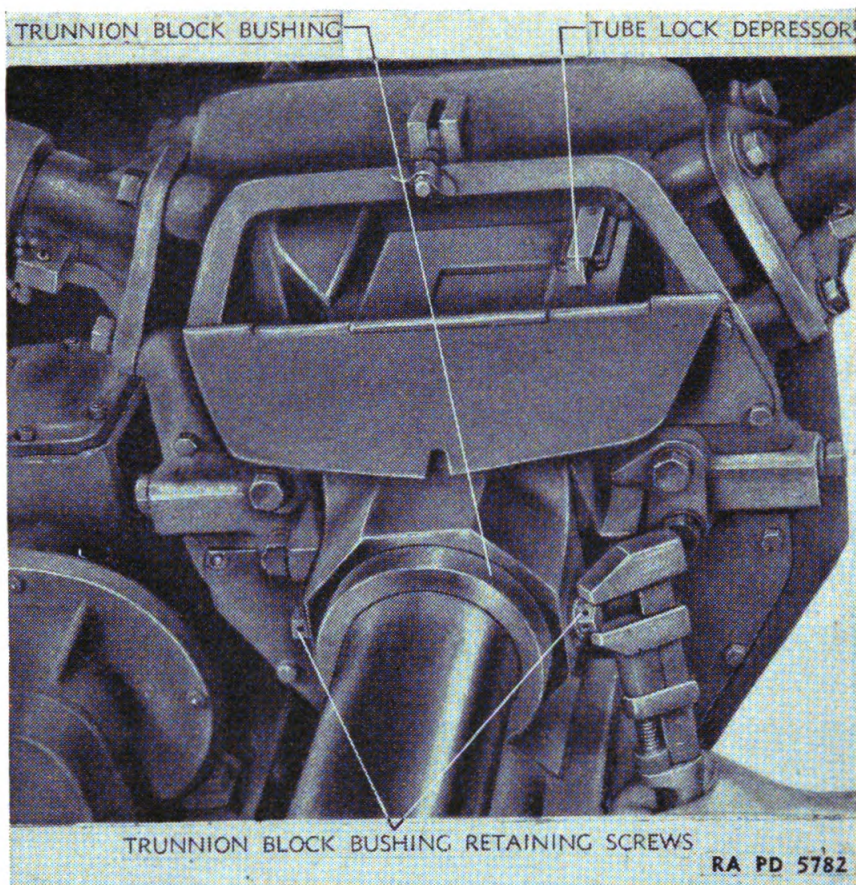


FIGURE 51.—Removing trunnion block bushing retaining screws.

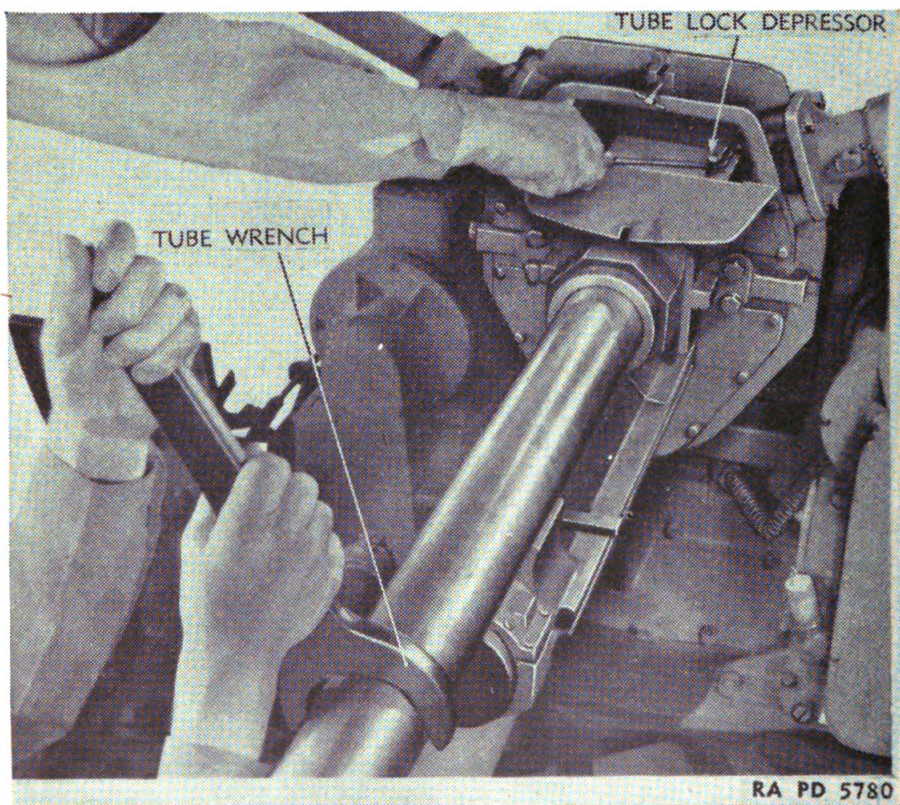


FIGURE 52.—Loosening gun tube.



of the thread in the tube extension. Screw in the tube clockwise by turning by hand until the tube is seated. When the tube is properly seated, the tube lock will automatically engage its slot in the tube, making a clicking sound.

(6) Replace the trunnion block bushing retaining screws.

**65. Gun.**—*a. Removal from cradle.*—(1) Remove the gun tube as described in paragraph 64.

(2) Remove ammunition tray.

(3) Disconnect the firing mechanism by removing trigger connector bracket lever behind the feed box of the gun.

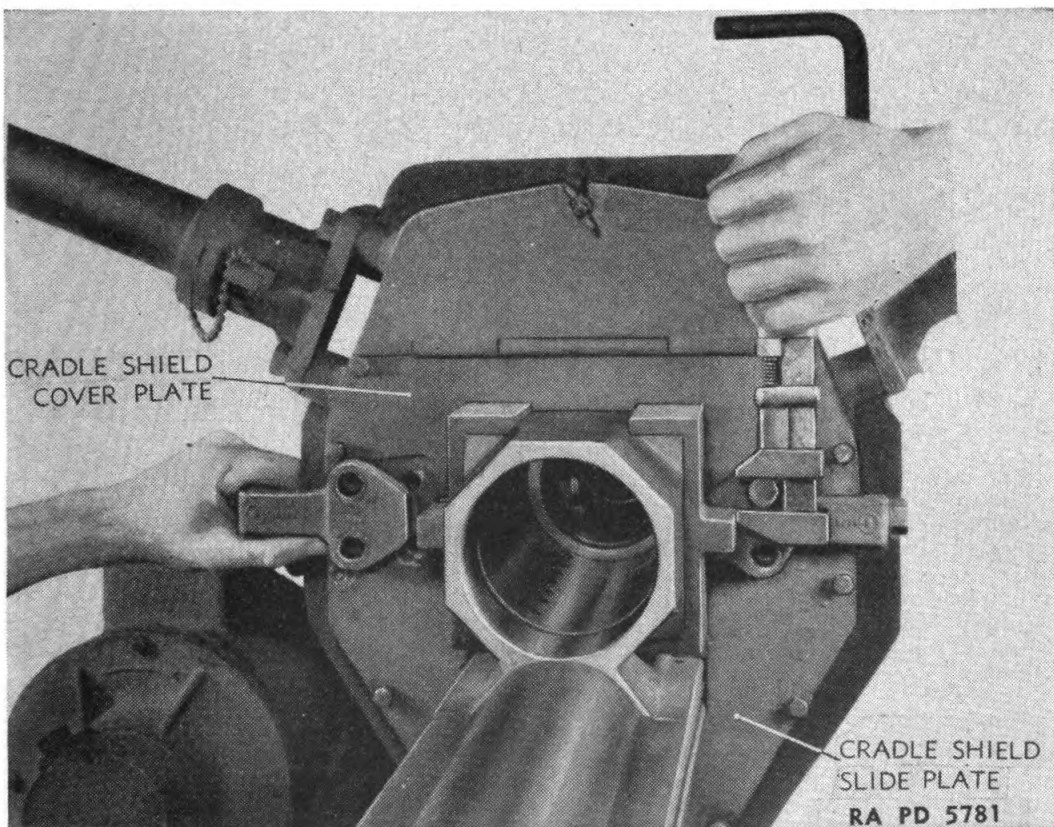


FIGURE 53.—Removing gun mounting keys.

(4) Remove the two gun mounting keys, each held in place by 3 cap screws (fig. 53).

(5) Remove the cradle shield cover plate held in place by 4 cap screws (M3A1 carriage).

(6) Remove the 2 cradle shield slide plates, each held by 4 cap screws (fig. 54).

(7) Slide the gun out of the cradle. Three or four men will be required to carry the gun to a suitable resting place.

*b. Installation in cradle.*—Installation of the gun in cradle should be in the reverse order of removal.

**66. Back plate assembly.**—*a. Removal.*—Depress the back plate latch and slide the back plate assembly down and out of the slide (fig. 55).

*b. Disassembly* (fig. 56).—(1) Remove buffer adjusting screw.

(2) The buffer springs and buffer pieces are now free to be shaken out of the back plate body assembly.

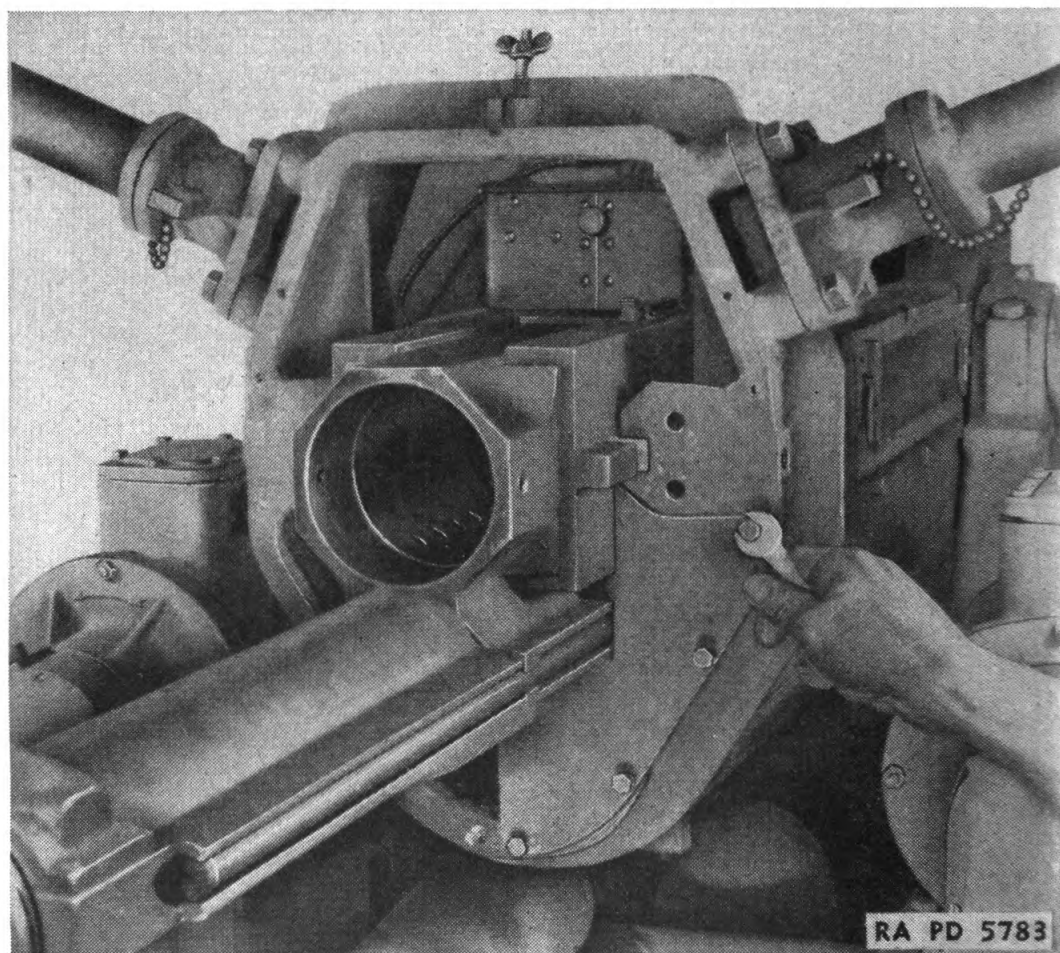


FIGURE 54.—Removing cradle shield slide plates.

(3) Remove buffer plunger stop screw.

(4) Buffer plunger will come out of its opening in the back plate assembly.

*c. Assembly.*—The components can be assembled in the reverse order of disassembly.

*d. Installation.*—Depress the back plate latch and slide the back plate assembly up into the slide. Release the latch and ascertain that it will secure the back plate assembly in place.



**67. Removal of lock frame assembly.**—*a.* Make sure that the lock frame assembly is in the in-battery position.

*b.* Remove the back plate assembly as described in paragraph 66.

*c.* Disconnect the driving spring assembly from the lock frame as follows:

(1) Lift the driving spring rod hook safety and rotate it downward.

(2) Lift the driving spring rod hook up and off the lock frame stud (fig. 57).

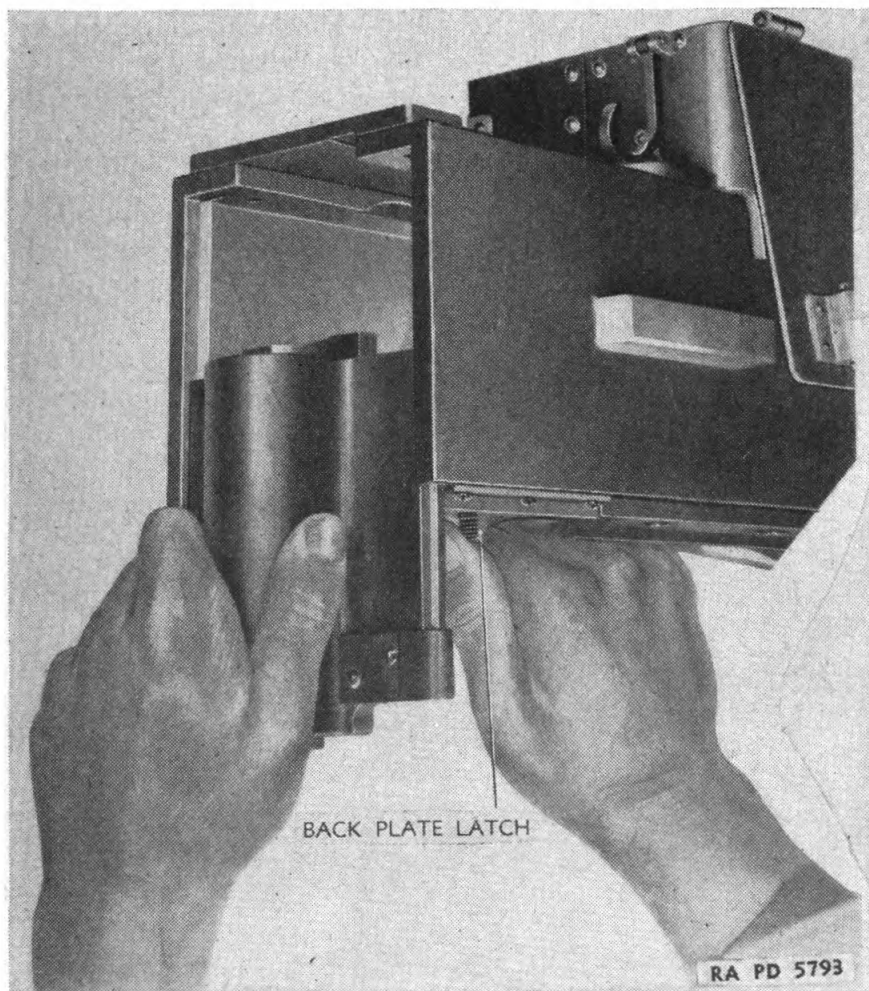


FIGURE 55.—Removing back plate assembly.

*d.* Remove the lock frame from the gun by sliding the lock frame out to the rear. Keep a firm grip on top of the lock frame and on the operating lever in order to prevent the operating lever from springing forward and injuring the operator.

*e.* When the lock frame has been removed from the gun, carefully swing the operating lever forward.

**68. Disassembly of lock frame assembly** (fig. 58).—*a. Op-*

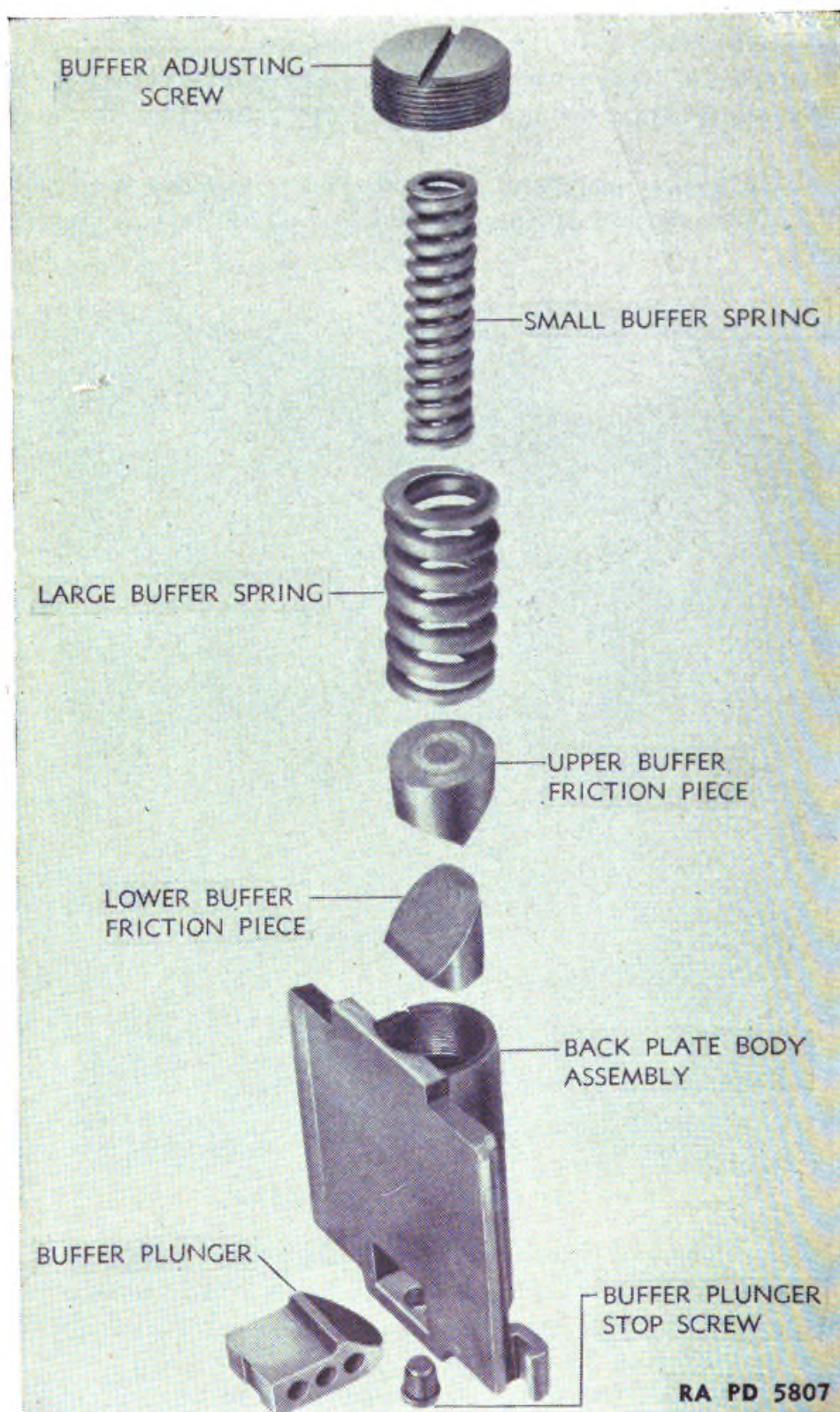


FIGURE 56.—Disassembly of back plate assembly.



*erating lever spring and lock assembly.*—(1) Turn operating lever down.

(2) Depress the operating lever spring lock with a screw driver. Rotate it about one-fourth of a turn counterclockwise and ease out (fig. 59).

(3) Remove the operating lever spring and operating lever spring follower.

*b. Operating lever assembly.*—(1) Remove cotter pin.

(2) Remove operating lever pivot pin.

(3) Remove operating lever assembly.

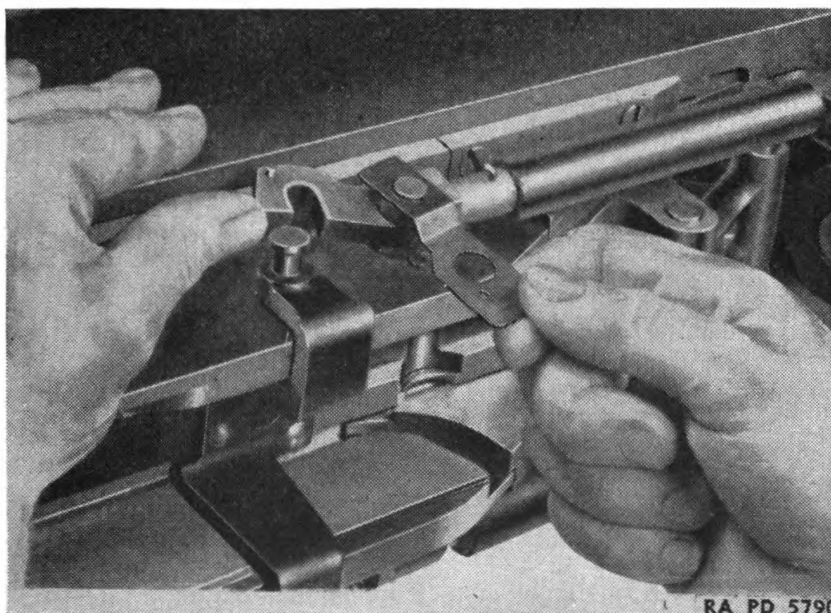


FIGURE 57.—Removal of driving spring assembly from lock frame.

*c. Cocking lever.*—(1) Remove cotter pin.

(2) Remove cocking lever pin.

(3) Remove cocking lever through bottom of lock frame.

*d. Extractor.*—(1) Remove cotter pin.

(2) Lift out extractor pin.

(3) Remove extractor and extractor spring.

*e. Sear.*—(1) Remove cotter pin.

(2) Lift out sear pin.

(3) Remove sear and sear spring.

*f. Hammer.*—(1) Remove cotter pin.

(2) Press on back of hammer spring guide and remove hammer spring guide pin.

(3) Ease out hammer spring guide and hammer spring.

(4) Remove hammer from rear of lock frame.

**69. Assembly and installation of lock frame.**—*a. Assembly.*—Components are assembled in the reverse order of disassembly.

*b. Installation.*—Installation is in the reverse order of removal from the gun.

**70. Driving spring assembly.**—*a. Removal.*—(1) Disconnect the driving spring rods from the lock frame as in paragraph 67c.

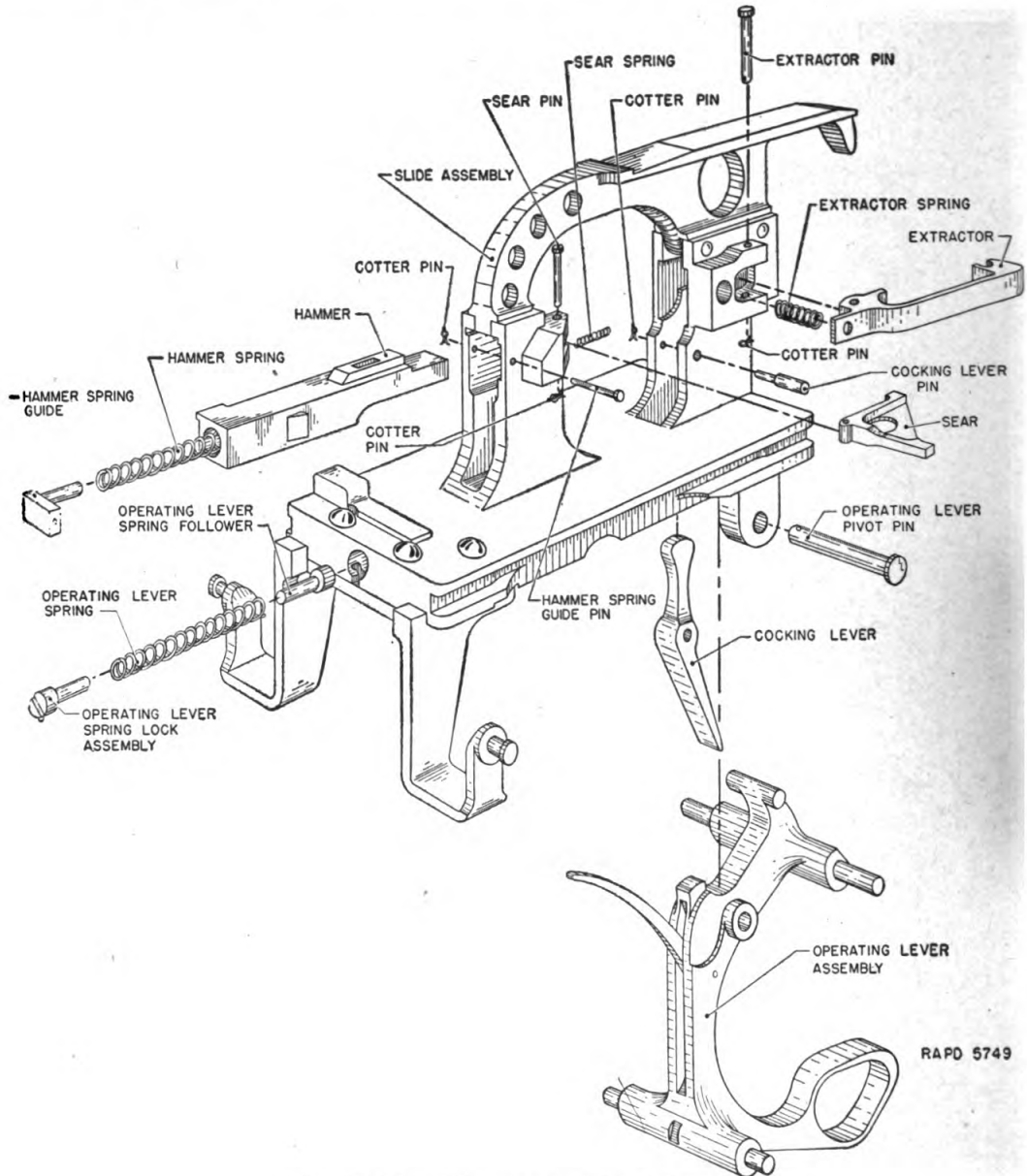


FIGURE 58.—Disassembly of lock frame.

(2) Disconnect the driving spring assembly from the tube extension by pulling the driving spring tube connection pin knob (found on the bracket which connects driving spring to tube extension) to the rear and twisting the driving spring tube so that it is disengaged from the tube extension.



(3) Remove the driving spring assembly from the gun.

*b. Installation.*—The assembly is installed in the reverse order of removal.

**71. Breechblock.**—*a. Removal.*—(1) Raise the carrier until caught by the carrier catch.

(2) Pull the lock frame to the rear until caught by the carrier dog.

(3) Pull out breechblock stop retaining pin knob which releases breechblock stop (fig. 60). Lower the breechblock stop and allow the breechblock to drop out.

*b. Disassembly* (fig. 61).—(1) Hold a finger over the back part of the firing pin.

(2) Push out the firing pin stop pin by means of a piece of wire or a nail.

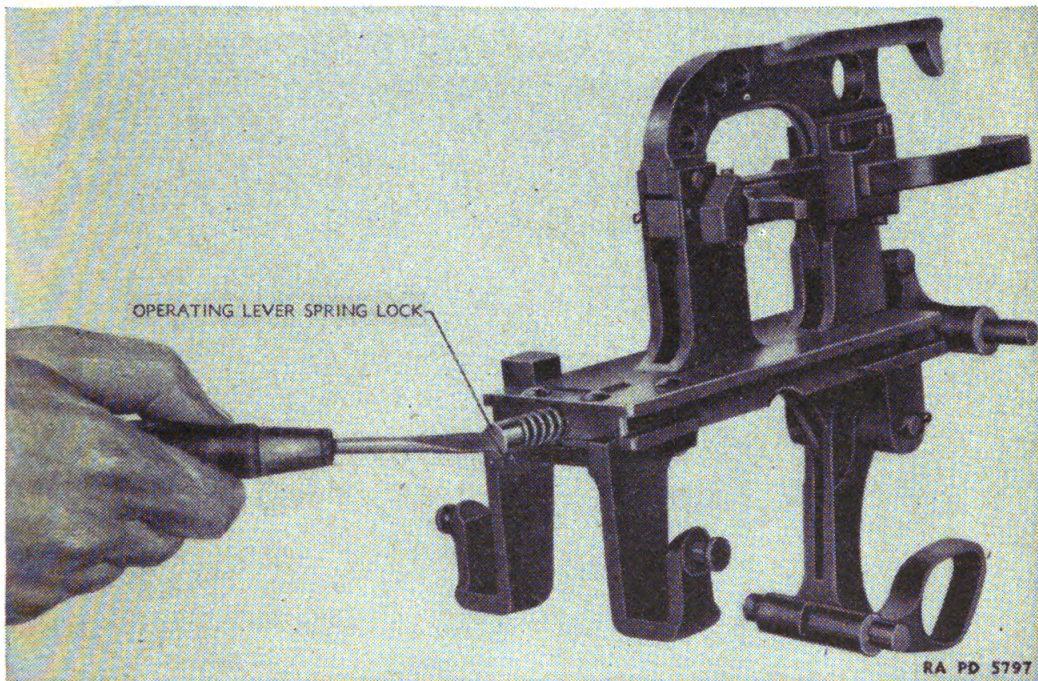


FIGURE 59.—Removal of operating lever spring lock assembly.

(3) Ease out the firing pin and firing pin spring.

*c. Assembly.*—Assemble in the reverse order of disassembly. Be sure that the flat on the firing pin will line up with the firing pin stop pin.

*d. Installation.*—(1) Reverse the operation for removal of breechblock.

(2) When replacing the breechblock and the breechblock stop, be sure that the breechblock is resting on the breechblock stop before returning the lock frame to battery position.

**72. Removal of tube extension.**—*a.* Remove breechblock assembly as described above.



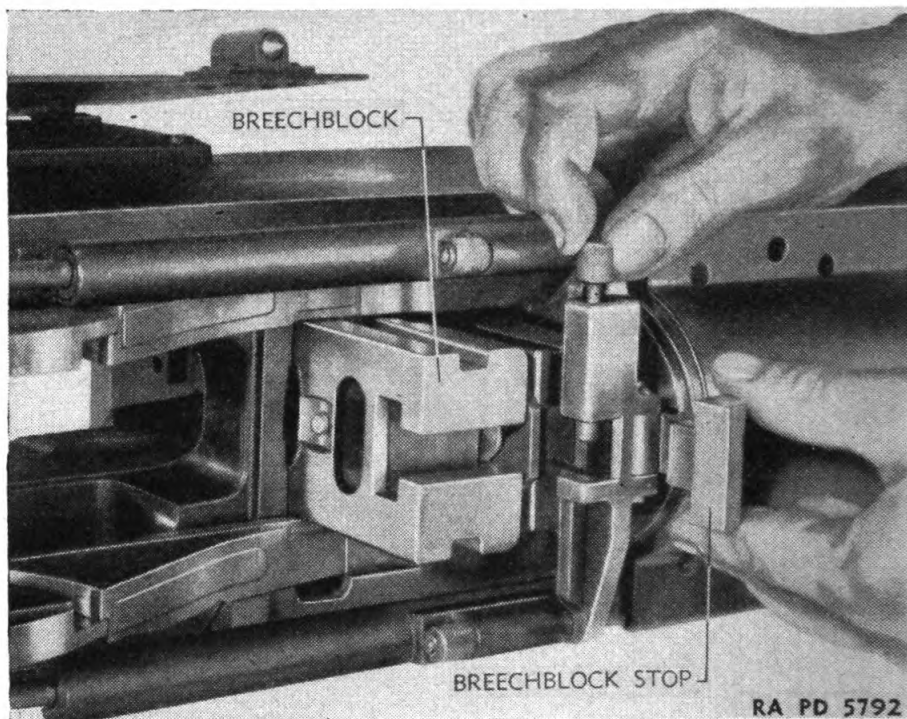


FIGURE 60.—Releasing breechblock stop for removal of breechblock.

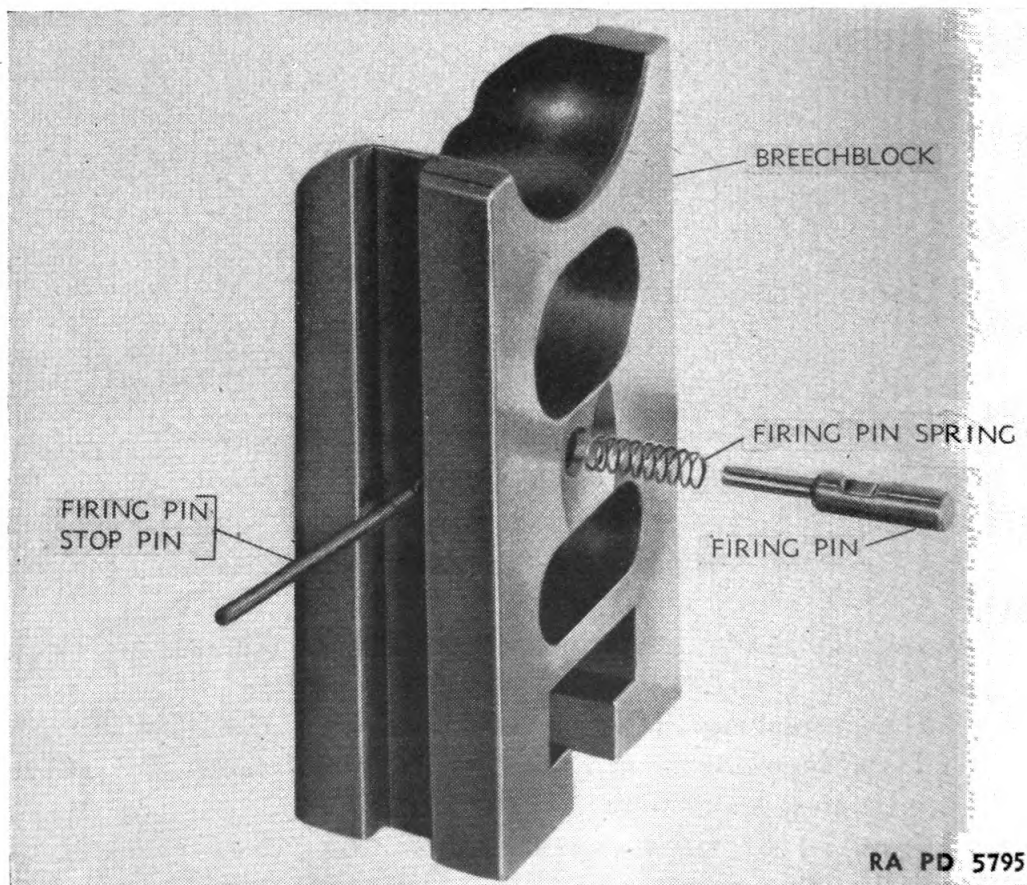


FIGURE 61.—Disassembly of breechblock.

- b.* Remove back plate assembly as described above.
- c.* Remove driving spring assembly as described above.
- d.* Remove lock frame assembly as described above.
- e.* Remove gun tube as described above.
- f.* Remove accelerator cam assembly as follows:
  - (1) Push accelerator cam to the rear.
  - (2) Press accelerator cam stud into trunnion block.
  - (3) Remove cam through back plate opening.



FIGURE 62.—Removal of recuperator piston rod nut.

- g.* Remove feed lever as follows (fig. 68):
  - (1) Unlock feed lever pin assembly.
  - (2) Remove feed lever pin assembly by pulling it out of right side plate of feed box.
  - (3) Lift feed lever assembly up and out of feed box.
- h.* Remove carrier assembly as follows (fig. 68):
  - (1) Unlock carrier pin assembly.
  - (2) Remove carrier pin assembly by pulling it out of left side plate of feed box.

(3) Remove carrier assembly by rotating it down and out through back of trunnion block.

i. Make sure gun is in a horizontal position.

j. Remove recuperator piston rod nut by means of recuperator and piston rod nut wrench (fig. 62).

k. Pull tube extension out through rear of trunnion block.

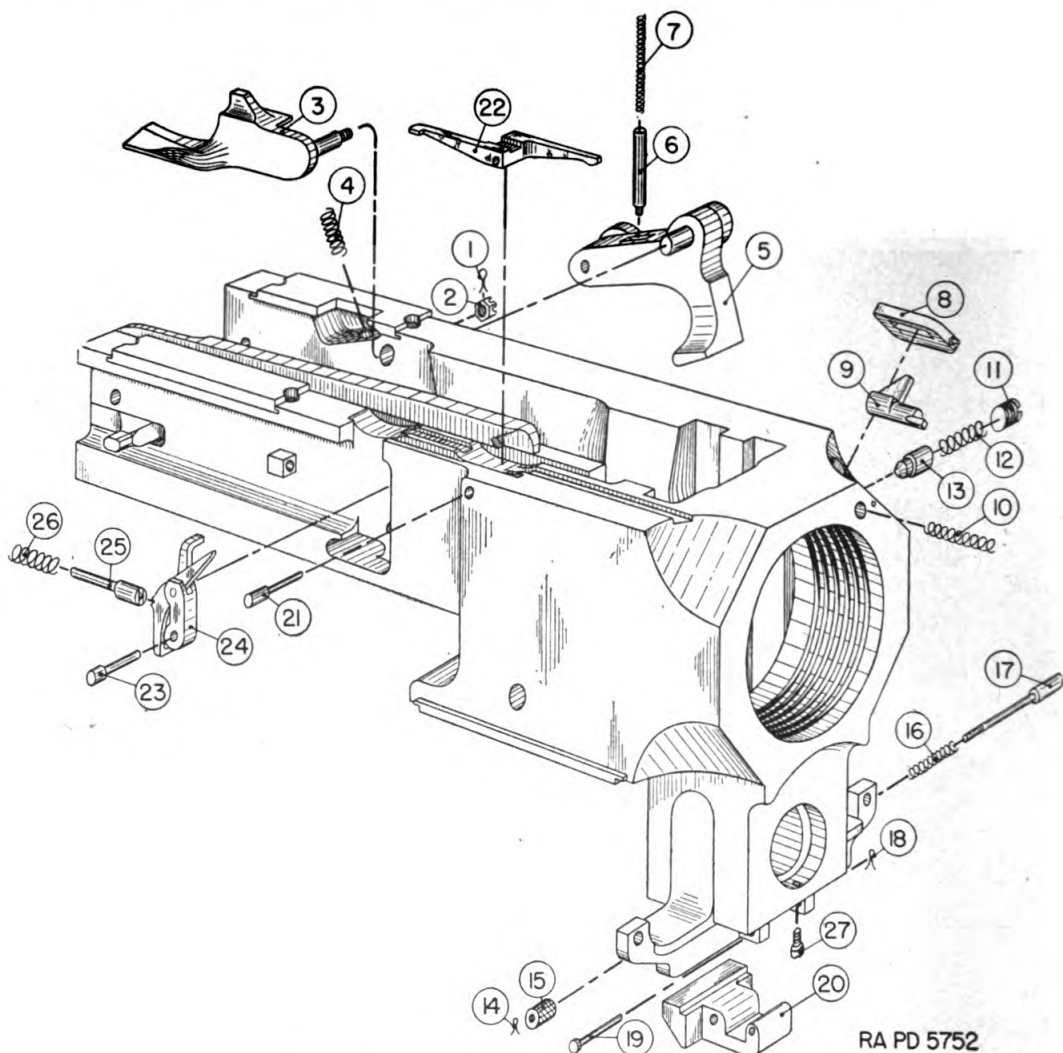


FIGURE 63.—Disassembly of tube extension.

**73. Disassembly of tube extension (fig. 63).—a. Ejector assembly.**—(1) Remove cotter pin which secures ejector nut in place.

(2) Remove ejector nut.

(3) Press ejector down and slide it out toward center portion of tube extension. Be careful not to let ejector spring jump out.

**b. Accelerator assembly.**—(1) Depress accelerator spring plunger into tube extension body by means of a screw driver (fig. 64).



- (2) Remove accelerator by pulling to the left of tube extension.
- (3) Ease out accelerator spring and plunger.

*c. Tube lock.*—(1) Remove tube lock plate assembly by depressing its plunger with a piece of wire as shown in figure 65. Lift out tube lock assembly.

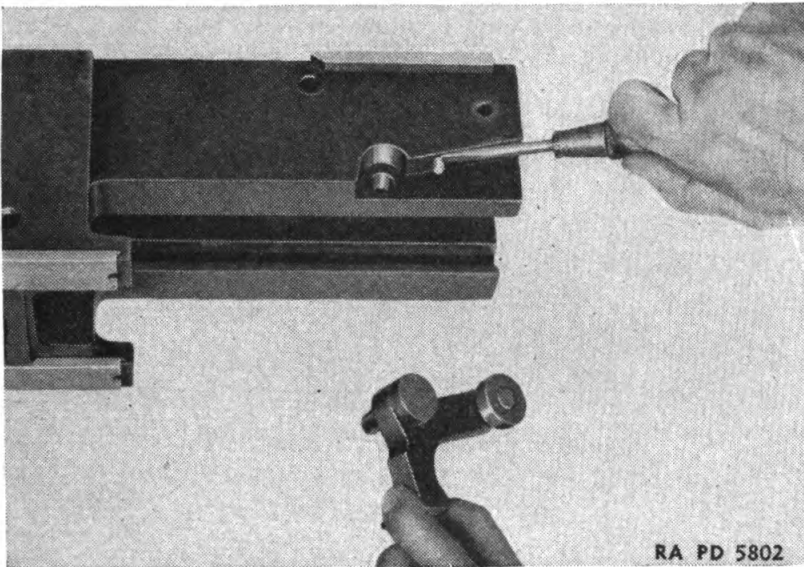


FIGURE 64.—Removal of accelerator.

- (2) Push tube lock against tube lock spring and lift tube lock out of its receptacle.
- (3) Remove tube lock spring by pushing it forward in its opening.

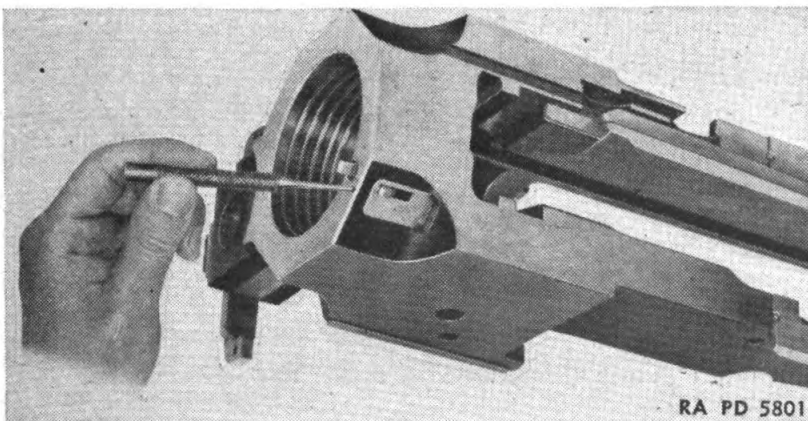


FIGURE 65.—Removal of tube lock plate assembly.

*d. Breechblock plunger.*—Unscrew breechblock plunger screw to remove breechblock plunger and spring.

- e. Breechblock stop.*—(1) Remove the two cotter pins.
- (2) Unscrew breechblock stop retaining pin knob.

- (3) Ease out breechblock stop retaining pin and spring.
- (4) Remove breechblock pin. The breechblock stop is now free from the tube extension.

*f. Trigger trip.*—(1) Remove trigger trip pin (fig. 66).

(2) Lift out trigger trip.

*g. Trigger lever assembly.*—(1) Remove trigger pin.

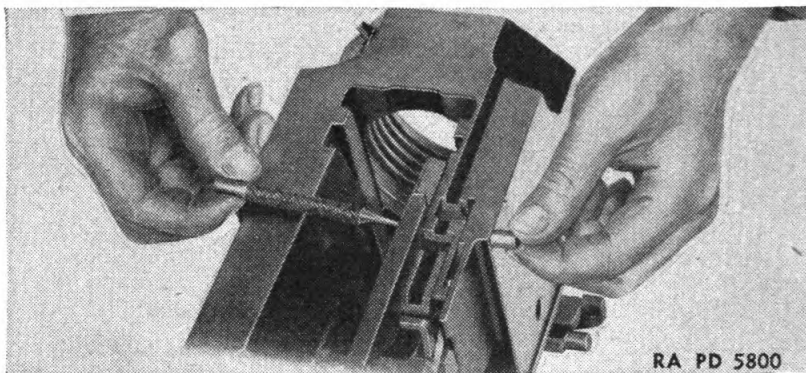


FIGURE 66.—Removal of trigger trip pin.

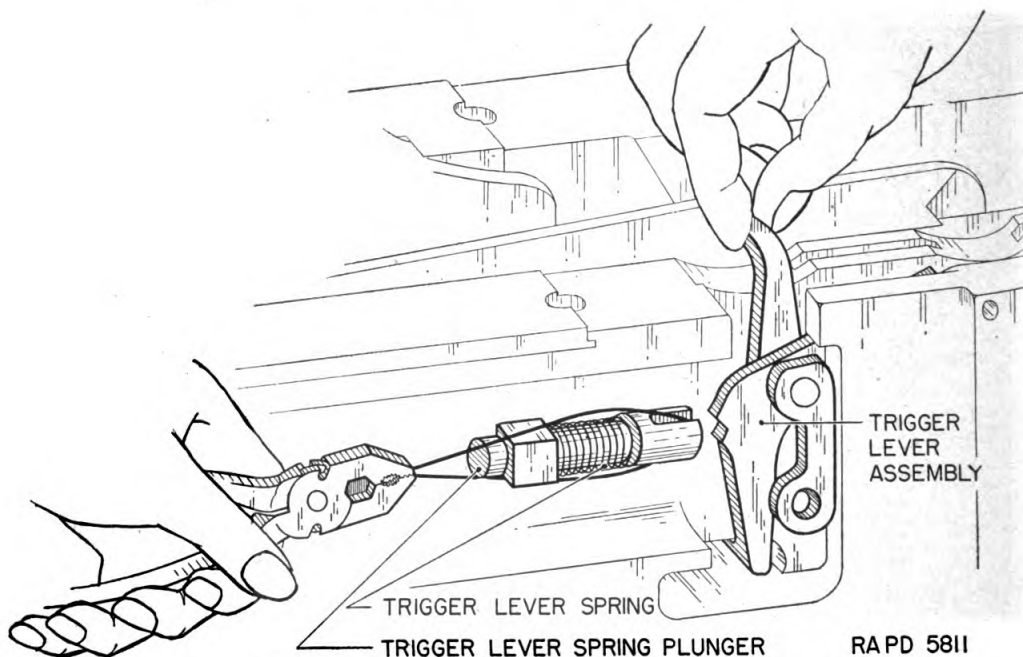


FIGURE 67.—Removal of trigger lever assembly.

(2) Loop a piece of wire around the front portion of trigger lever spring plunger and pull plunger to the rear by means of a pair of pliers as shown in figure 67. If the wire and pliers are not available, the plunger must be depressed by means of a screw driver or the plunger pulled back by means of a pair of pliers holding the back part of the plunger.

(3) Lift out trigger lever assembly.

(4) Ease out trigger lever spring plunger and spring.

**74. Assembly and installation of tube extension.**—*a. Assembly.*—Components are assembled in the reverse order of disassembly.

*b. Installation.*—(1) Replace the tube extension in the reverse order of removal.

(2) The recuperator piston rod nut should not be tightened before the gun tube is screwed into the tube extension. If, when the tube extension is in place, the tube does not seat properly in its socket, then the recuperator piston rod nut should be removed and a further attempt made to seat the tube in place. If the gun tube is still not properly seated or if the gun tube cannot be seated, remove the tube extension and assemble the gun tube to the tube extension outside of the gun. The tube and tube extension will then have to be put into the trunnion block through the back plate opening. The recuperator piston rod nut can then be assembled to the recuperator piston rod by means of the proper wrench. When assembling the recuperator piston rod nut, its final setting should be such that a flat surface is parallel to the breechblock stop. When the breechblock stop is rotated to its closed position, the stop acts as a lock for the recuperator piston rod nut.

**75. Disassembly of feed box mechanism** (fig. 68).—*a. Feed lever assembly.*—(1) Loosen locking screw and remove feed lever pin assembly from right side plate of feed box.

(2) Lift feed lever assembly up and out of feed box mechanism.

*b. Feed slide lever assembly.*—(1) Remove feed slide lever pin.

(2) Remove feed slide lever assembly.

*c. Feed crank assembly.*—Lift out.

*d. Carrier assembly.*—(1) Loosen locking screw and remove carrier pin assembly from left side plate of feed box.

(2) Remove carrier assembly by rotating it down and out through back of trunnion block opening.

*e. Feed slide return lever assembly.*—(1) Lift out feed slide return lever pin.

(2) Remove feed slide return lever assembly.

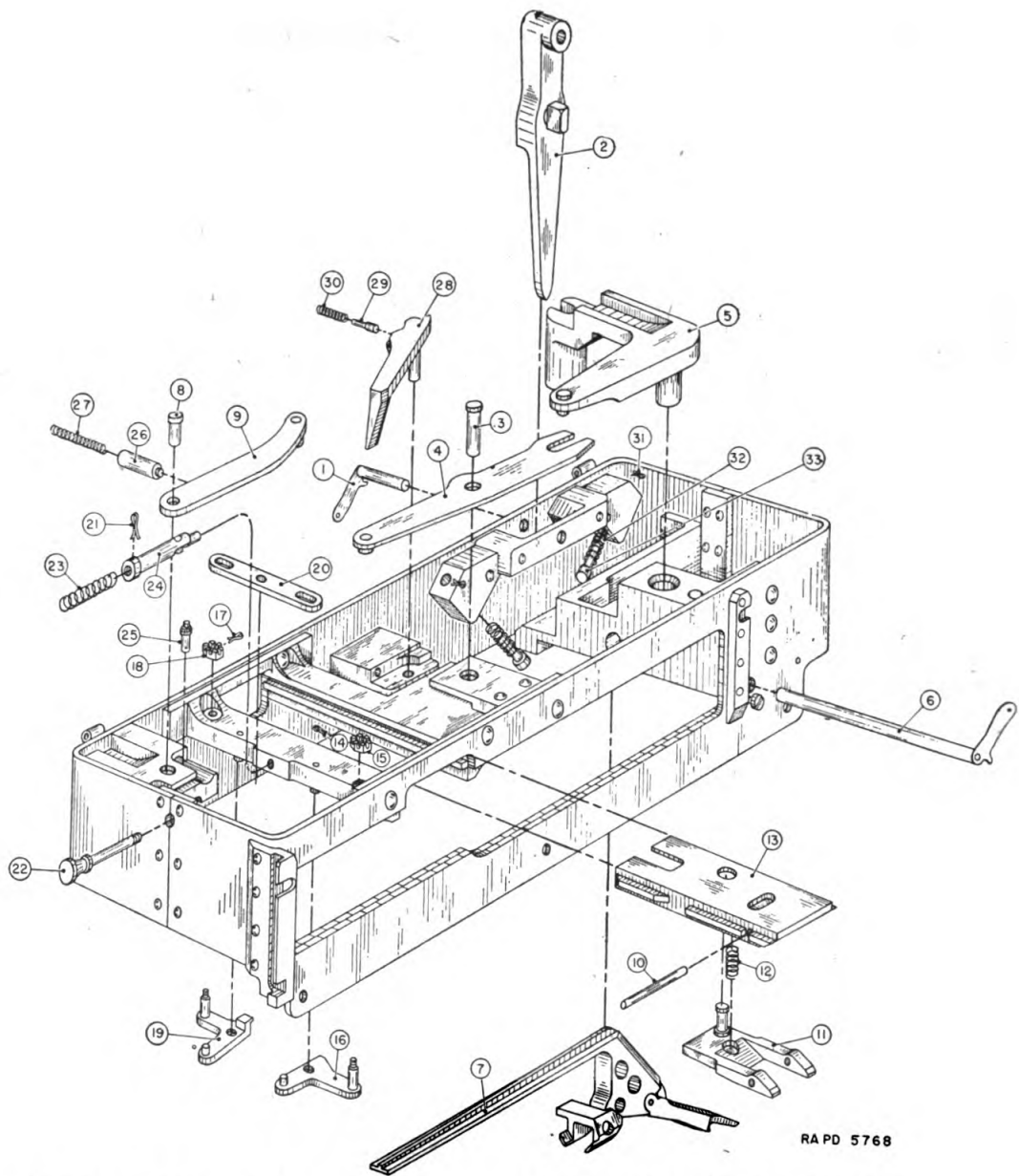
*f. Feed slide and feed pawl assembly.*—(1) Push feed slide and feed pawl assembly to left.

(2) Push feed pawl pin from the two parts by means of a piece of wire (fig. 69).

(3) Catch feed pawl assembly.

(4) Remove feed slide from its slideway.

*g. Cartridge feeder holding and stop pawl assemblies.*—(1) Remove cotter pins from cartridge feeder holding and stop pawl nuts.



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1. Feed lever pin assembly.
2. Feed lever assembly.
3. Feed slide lever pin.
4. Feed slide lever assembly.
5. Feed crank assembly.
6. Carrier pin assembly.
7. Carrier assembly.
8. Feed slide return lever pin.
9. Feed slide return lever assembly.
10. Feed pawl pin.
11. Feed pawl assembly.
12. Feed pawl spring.
13. Feed slide.
14. Cotter pin.
15. Cartridge feeder holding pawl nut.
16. Cartridge feeder holding pawl assembly.
17. Cotter pin.
18. Cartridge feeder stop pawl nut.
19. Cartridge feeder stop pawl assembly.
20. Cartridge feeder pawl connector.
21. Cotter pin.
22. Cartridge feeder pawl handle.
23. Cartridge feeder pawl spring.
24. Cartridge feeder pawl connector shaft assembly.
25. Feed slide lever plunger pin.
26. Feed slide return lever plunger.
27. Feed slide return lever plunger spring.
28. Carrier catch.
29. Carrier catch spring plunger.
30. Carrier catch spring.
31. Cotter pin.
32. Feed lever spring.
33. Feed lever spring plunger.

FIGURE 68.—Disassembly of feed box.



(2) Remove both nuts.

(3) Remove both pawls.

*h. Cartridge feeder pawl connector.*—Remove.

*i. Cartridge feeder pawl connector shaft assembly.*—(1) Remove cotter pin.

(2) Unscrew cartridge feeder pawl handle.

(3) Remove cartridge feeder pawl spring.

(4) Remove cartridge feeder pawl connector shaft assembly.

*j. Feed slide return lever plunger.*—(1) Depress feed slide return lever plunger with a screw driver and at the same time push out feed slide lever plunger pin (fig. 70).

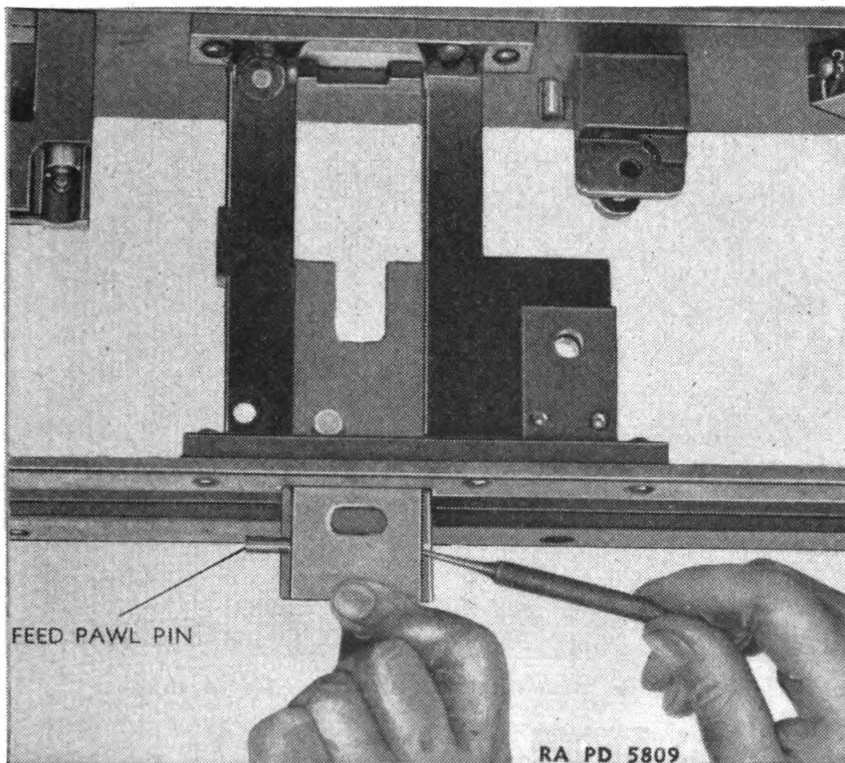


FIGURE 69.—Removal of feed slide assembly.

(2) Ease out feed slide return lever plunger and spring by means of the screw driver.

*k. Carrier catch.*—(1) Depress carrier catch spring plunger with a screw driver.

(2) Lift out carrier catch.

(3) Ease out carrier catch plunger and spring by means of the screw driver.

*l. Feed lever plungers.*—(1) Depress plunger from beneath bracket and remove the cotter pin.

(2) Ease out plunger and spring.

**76. Assembly of feed box mechanism.**—Components are assembled in the reverse order of disassembly.

**77. Trigger and trigger bar.**—*a. Removal.*—(1) The trigger is removed by removing the cotter pin and pin which secure the trigger to the bracket on the upper back portion of the feed box.

(2) The trigger bar is removed from the gun after the lock frame and tube extension have been removed. The trigger bar can then be slid in its groove in the upper right-hand portion of the trunnion block and lowered out of position.

*b. Installation.*—The trigger bar must be placed in its slideway so that the notch which is closer to one end of the bar lies towards the

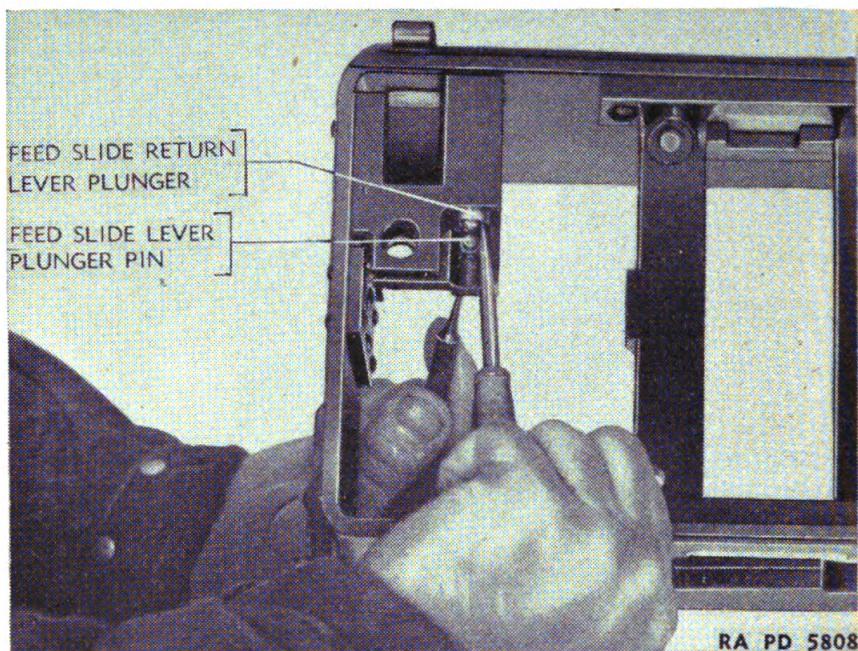


FIGURE 70.—Removal of feed slide return lever plunger.

front of the gun. At the same time be sure that the small bent end at the rear of the trigger bar points upward and through the hole behind the feed box. The trigger must be assembled so that the protruding piece of the trigger bar fits into the notch on the bottom of the trigger. This is important, otherwise the gun will not fire or will fire without a pull on the trigger.

**78. Removal of wheels from carriages.**—The socket wrench and handle (fig. 71) are used to remove the nuts which secure the wheel in place. The wheel stud nuts on the left side of the carriage have left-hand threads, while the wheel stud nuts on the right side of the carriage have right-hand threads. By removing the five stud nuts the wheel and tire can be removed.



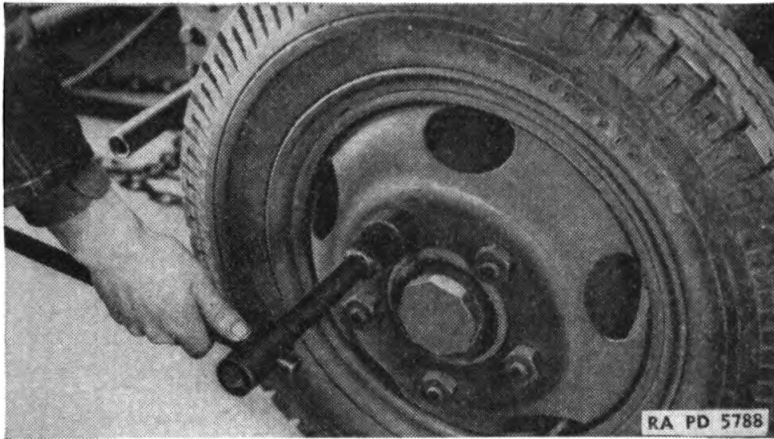


FIGURE 71.—Socket wrench for removal of wheels.

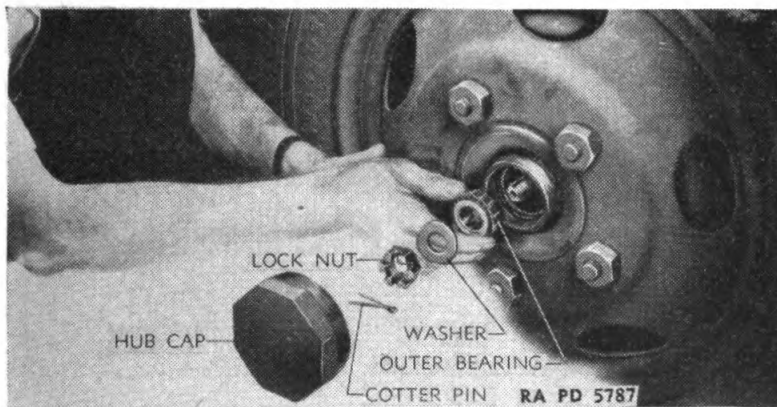


FIGURE 72.—Disassembly for removal of brake drum and wheel.

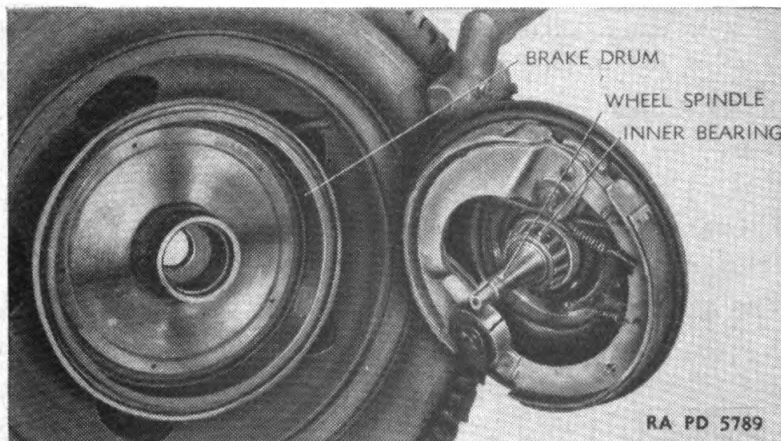


FIGURE 73.—Wheel and brake drum removed from brake assembly.

**79. Removal of brake drum and wheel (fig. 72).—***a.* Jack up the wheel.

*b.* Unscrew hub cap.

*c.* Remove cotter pin.

*d.* Unscrew lock nut.

*e.* Grab the wheel at two opposite points and pull slightly. This should loosen the outer bearing from its seat.

*f.* Remove washer and outer bearing.

*g.* Remove the wheel and brake drum from the axle spindle. The inner bearing and spindle (fig. 73) are now exposed for cleaning and lubrication.

*h.* When the brake drum and wheel are removed in this fashion, the brake lining should be inspected for wear or for presence of grease and oil.

**80. Installation of brake drum and wheel.—***a.* Place the inner bearing as far back as it will go on the wheel spindle (fig. 73). Place the wheel over the spindle and bearing and push it well back over the bearing. Place the outer bearing over the spindle (fig. 72).

*b.* Place washer over the spindle.

*c.* Screw lock nut onto the spindle and tighten the lock nut until there is a slight drag when the wheel is rotated.

*d.* Back off the lock nut until the wheel turns freely (one-half turn is usually sufficient) and insert cotter pin.

*e.* Replace hub cap.

**81. Replacement of counterpoise spring.—***a.* If adjustment of the counterpoise spring does not bring about the proper operation of this mechanism, replace the spring or springs. The M3 carriage has one spring, the M3E1 carriage has two springs, and the M3A1 carriage has two springs concentrically located in the cylinder.

*b.* To replace the spring in the counterpoise cylinder, the spring compressor (fig. 74) must be used. This consists of four parts:

(1) Spacing collar B.

(2) Rod F.

(3) Nut G.

(4) Ball bearing H.

*c.* With the gun carriage in traveling position, block or jack up the corner of the carriage where the spring is to be removed and take off the wheel.

*d.* Remove the top cover cap of the cylinder and cap (A) and insert the spacing collar (B) into the top of the cylinder. Replace the cap (A) and screw it down tight.



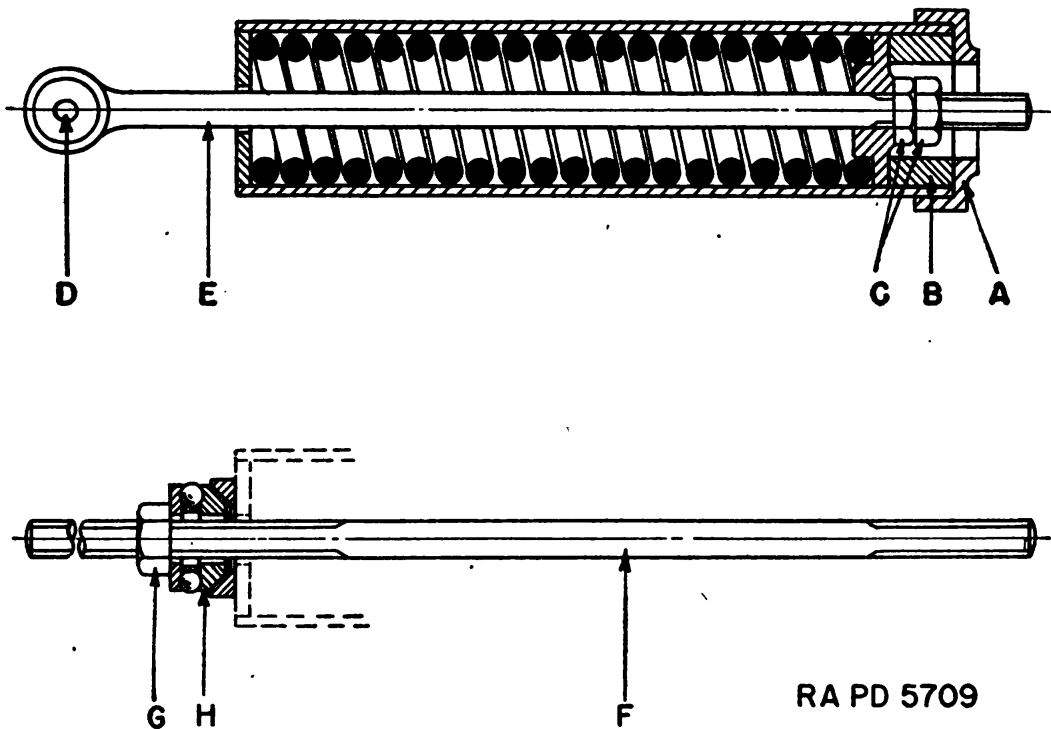


FIGURE 74.—Spring compressor for counterpoise cylinder.

*e.* Nuts (C) are then removed with the counterpoise cylinder wrenches, causing the spring to bear against the spacing collar.

*f.* Remove the plate covering the axle bracket (the bracket in which the counterpoise rod slides).

*g.* Insert a  $\frac{3}{8}$ -16 NC cap screw into the threaded hole in pin A146680 (fig. 75).

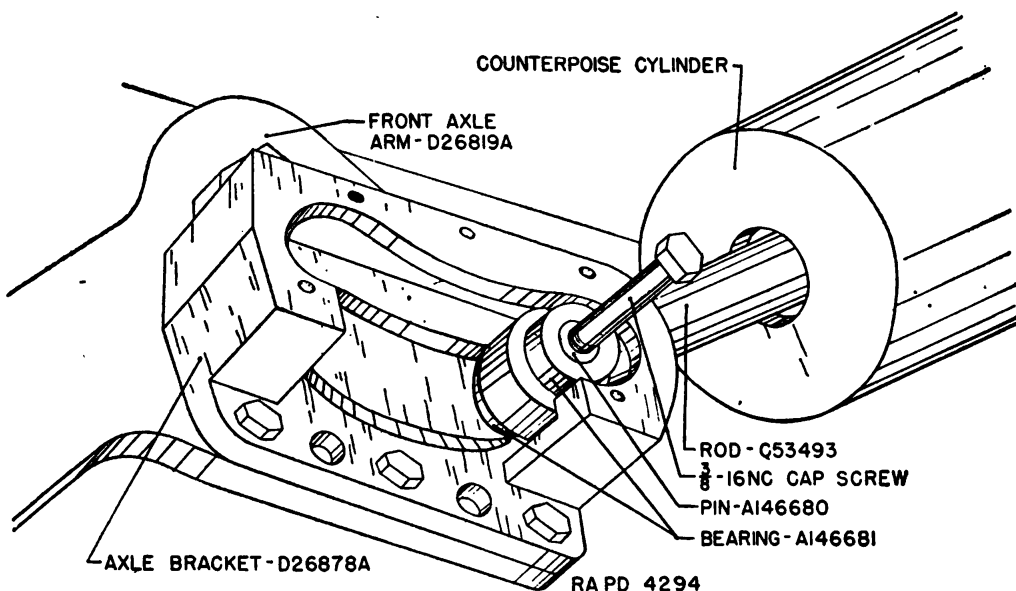


FIGURE 75.—Removal of counterpoise rod from axle bracket

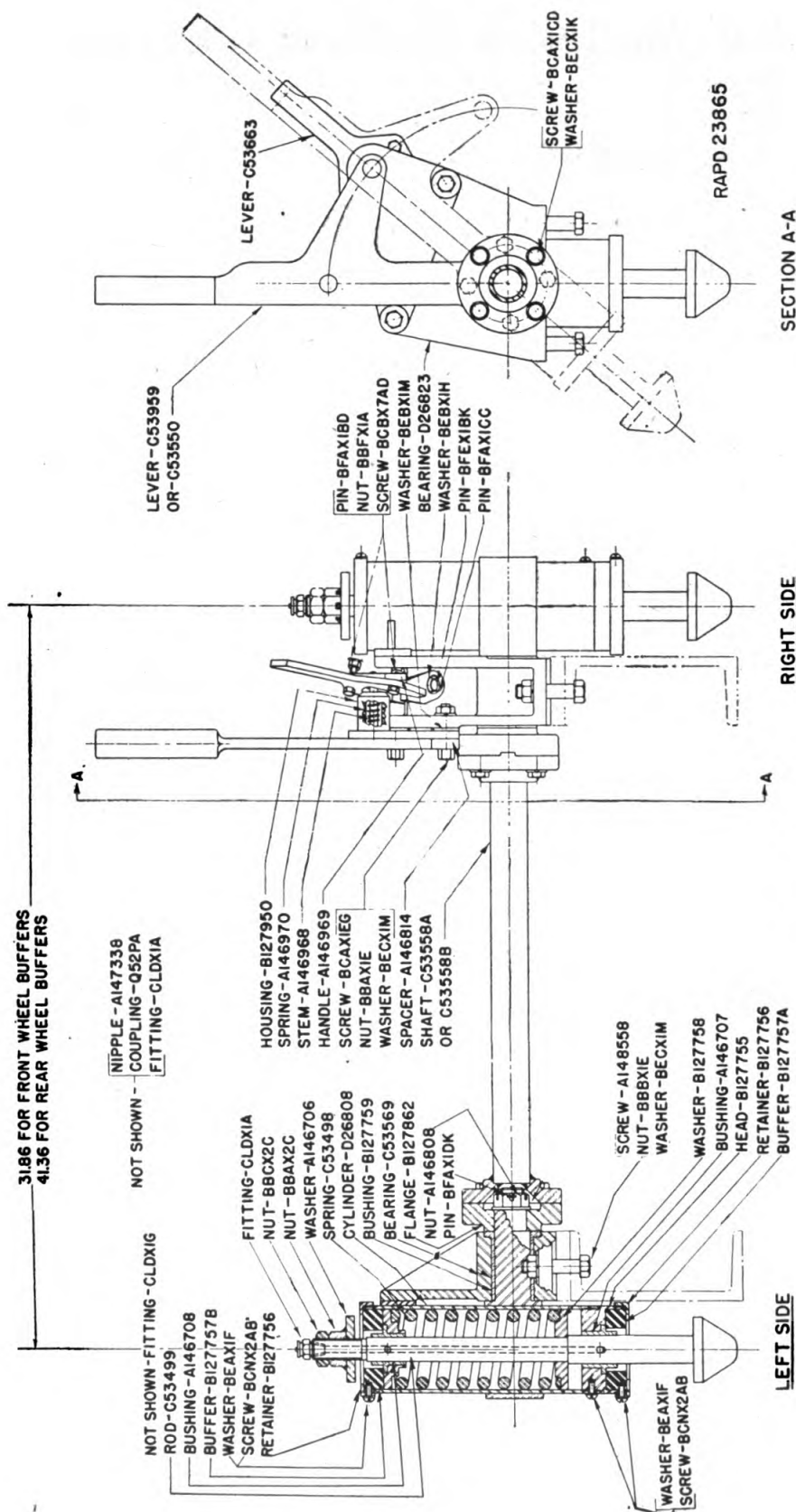


FIGURE 76.—Buffer assembly.

h. Tap out or pull out on the cap screw, thereby disengaging pin A146680 (pin (D) in fig. 74).

i. Remove bearings A146681.

j. Slide counterpoise rod C53493 (rod (E) in fig. 74) out of the bottom of the cylinder.

k. Revolve the counterpoise cylinder to a horizontal position and replace the rod that has been removed by rod (F) (fig. 74). Rod (F) should have assembled to it the bearing (H) and nut (G). Screw nuts (C) onto the top end of rod (F) with the socket wrench.

l. Tighten the nut (G) enough to remove the pressure from the spacing collar (B). Remove the cap (A) and the spacing collar (B) and unscrew the nut (G) until the spring is released to its free length.

m. Remove nuts (C) and take the spring or springs from the cylinder.

n. To install a new spring reverse the procedure given above, using a new spring in place of the one removed.

**82. Replacement of buffer mechanism spring.**—If adjustment of the buffer spring does not produce the correct action, or if it is broken, replacement of the spring will be necessary.

a. *Disassembly.*—Disassemble the cylinder for replacement of the spring as follows (fig. 76):

(1) Place the carriage in firing position.

(2) Remove the upper of the two screws (BCNX2AB) and washers (BEAX1F) in the lower end of the cylinder and unscrew the head (B127755) in which is secured the lower retainer (B127756), buffer, and bushing (A146707).

(3) Remove the lubrication fitting and nut (BBCX2C) located on the top end of the buffer rod.

(4) Unscrew the second nut of the buffer rod. As this nut is turned off, the spring expands and will push the rod and washer (B127758) out of the bottom of the cylinder. If this does not occur, tap the rod down and out of the cylinder.

b. *Assembly.*—(1) Assemble by placing all parts on the rod in their proper order, as shown in figure 76, and then push the threaded end of the rod up through the cylinder. Replace the two nuts (BBAX2C and BBCX2C), screw (BCNX2AB), and washer (BEAX1F).

(2) Adjust the buffer by means of the two nuts (BBCX2C and BBAX2C) so that the buffer will just rest on the axle arm in traveling position. During travel the two front buffers should be equally depressed by the axle arms; likewise the two rear buffers.

**83. Replacement of equilibrator springs (fig. 77).**—a. Remove the gun from the cradle.

- b. Remove cap (B162197).
- c. Elevate the cradle to its maximum point.
- d. Remove nut (BBAX2C).
- e. Nut (A217570) should be turned off the rod slowly, allowing the springs to extend to their free length.
- f. Remove bearing (CAFX1AE), head (B162196), and the two springs.
- g. Assemble in the reverse order of disassembly, using a new spring or springs in place of the defective ones.
- h. Adjust to give proper equilibrator action.

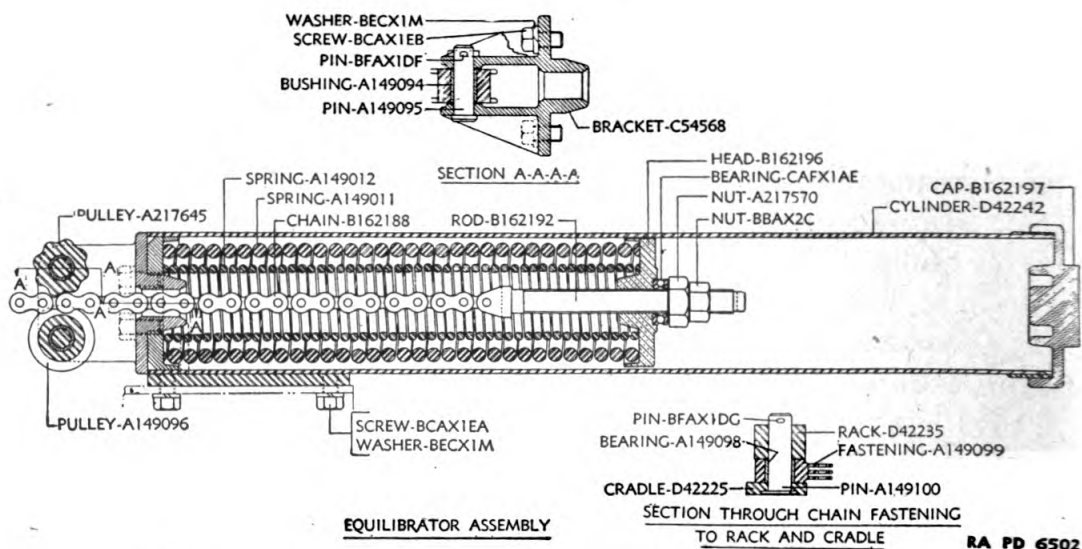


FIGURE 77.—Equilibrator assembly M3A1.

## SECTION IX

DISASSEMBLY AND ASSEMBLY OF CALIBER .50  
MACHINE GUN

	Paragraph
Removal from cradle.....	84
Removal of groups from gun.....	85
Replacing groups in gun.....	86
Disassembling.....	87
Assembling.....	88
Packing barrel.....	89
Changing barrels.....	90

**84. Removal from cradle.**—a. Disconnect trigger cable as described in paragraph 35b.

b. Remove the two nuts from the bottom of the machine gun mounting fork (fig. 32).

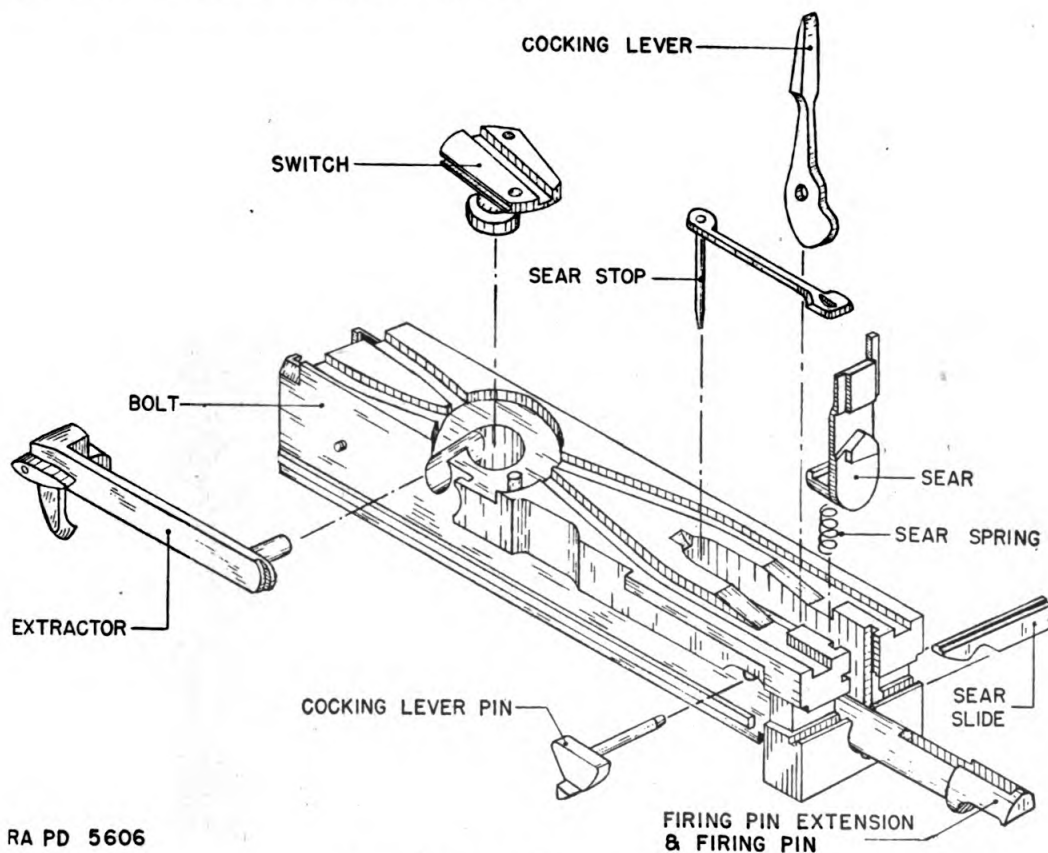


c. Remove the similar nuts from the bottom of the fork supporting the front end of the caliber .50 machine gun.

d. Lift the gun, together with the forks, from the cradle.

**85. Removal of groups from gun.**—*a. Cover.*—Release cover latch and open cover. The cover need not be removed as the other parts of the gun may be taken out without removing it.

**NOTE.**—Removal of the cover group is not recommended unless necessary for repair as it is difficult to reassemble due to the force required to compress the detent pawl spring.



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FIGURE 78.—Bolt group parts.

b. *Back plate.*—Release back plate latch lock and back plate latch and lift out back plate.

c. *Bolt group.*—Press forward and away from the side plate on end of driving spring rod to release the retaining pin in head of rod from the hole in the side plate. Remove driving spring rod. Draw bolt to the rear until the bolt stud is in line with the hole in center of slot in the side plate. Remove bolt stud from bolt. Remove the bolt, complete, out of the rear end of the gun casing.

d. *Oil buffer.*—Compress oil buffer body spring lock, using a cartridge point or a drift through the hole in the right-hand side plate.

Remove oil buffer, barrel extension, and barrel assembly by pulling out to the rear. Detach oil buffer assembly from barrel extension by pressing the accelerator forward.

**86. Replacing groups in gun.**—*a.* Hold barrel and barrel extension in the left hand and oil buffer assembly in the right hand. With the index finger holding the accelerator up under the barrel extension shank, start the breechblock depressors into the guideways in the barrel extension and press forward, allowing the shank of barrel extension to engage in the cross groove of the piston rod. Push forward as far as the oil buffer will go, having the accelerator back as far as possible. This will lock these components together so that the barrel, barrel extension, and oil buffer assembly may be placed in the casing of the gun as a unit. Push this unit forward in the casing until the lock of the oil buffer seats in the recess in the side plate.

*b.* Press cocking lever forward in bolt and insert bolt into the casing. Push bolt forward until the hole for the bolt stud is in line with the enlarged opening in center of slot in the side plate. Insert bolt stud in bolt, being sure that the collar on the bolt stud is inside the side plate. Push bolt completely forward guiding the extractor from the front with the fingers to prevent it from catching.

*c.* Insert driving spring rod assembly into the hole in bolt. Engage driving spring rod retaining pin in its seat in the right-hand side plate.

*d.* Replace back plate. When replacing the back plate make sure the latch lock is in the unlocked position until the back plate is latched.

*e.* Close and latch cover.

**87. Disassembling.**—*a. Bolt group* (fig. 78).—(1) Remove bolt group from gun.

(2) Remove extractor by rotating upward and pulling out from bolt. The ejector and ejector spring can be removed after driving out the ejector pin.

(3) Lift bolt switch off bolt switch stud.

(4) Rotate cocking lever fully backward and release firing pin by pushing down the sear. Remove cocking lever pin and cocking lever.

(5) With thin end of cocking lever swing the sear stop out of its groove in the bolt into the center of slot in the bolt; then turn bolt over and push sear stop out of engagement with firing pin spring. Reverse bolt and remove sear stop from slot.

(6) Depress sear and remove sear slide. Pull out sear and sear spring.

(7) By holding the bolt with front end slightly elevated the firing pin extension and firing pin will drop out. The firing pin spring

can be removed from the firing pin extension by driving out the firing pin spring stop pin. Take precautions to prevent firing pin spring from flying out during the operation. This should not be done unless it is necessary to replace the firing pin spring.

(8) The driving spring and driving spring rod collar can be removed from the driving spring rod assembly by driving out the driving spring rod collar stop pin from the driving spring rod. This should not be done unless it is necessary to replace the driving spring.

*b. Oil buffer group (fig. 79).—*(1) Remove oil buffer, barrel extension, and barrel assembly from gun. Detach oil buffer from barrel extension by pressing accelerator forward.

(2) Remove oil buffer body spring lock by pulling it to the rear.

(3) Hold oil buffer body, bottom up, in the left hand with the index finger between depressors and prongs of accelerator. With the point of a cartridge press the stud on the end of the oil buffer tube lock spring to disengage it from its hole in the oil buffer tube body. At the same time raise accelerator upward and rotate to the rear. Remove oil buffer tube lock spring.

(4) Drive out accelerator pin and remove accelerator.

(5) The oil buffer tube assembly should not be disassembled unless absolutely necessary to replace the oil buffer spring. To disassemble, depress oil buffer spring guide sufficiently to clear oil buffer piston rod pin; turn oil buffer spring guide until oil buffer piston rod pin will pass through slots in the guide. Remove guide and spring.

**Caution.**—The oil buffer spring is under sufficient compression to cause injury to personnel.

*c. Barrel group.*—(1) Remove barrel by unscrewing from barrel extension.

(2) Remove barrel locking spring by sliding it forward out of its seat in barrel extension.

(3) Push out breech lock pin and remove breech lock.

(4) The barrel sleeve is permanently assembled to the barrel and should not be removed.

*d. Cover group (fig. 80).—*(1) Remove cover pin cotter pin. Drive out cover pin and lift cover free from trunnion block.

(2) Remove belt feed lever pivot stud cotter pin and pry belt feed lever off its stud, taking care while doing so that the belt feed lever plunger and spring do not fly out. In removing the belt feed lever see that toe of lever is in line with slot in cover, otherwise it will not pass out.

(3) Remove belt feed lever plunger and belt feed lever plunger spring from belt feed lever.

- (4) Remove belt feed slide complete from its guides in cover.
- (5) Push out belt feed pawl pin which will enable the belt feed pawl, belt feed pawl spring, and belt feed pawl arm to be separated.

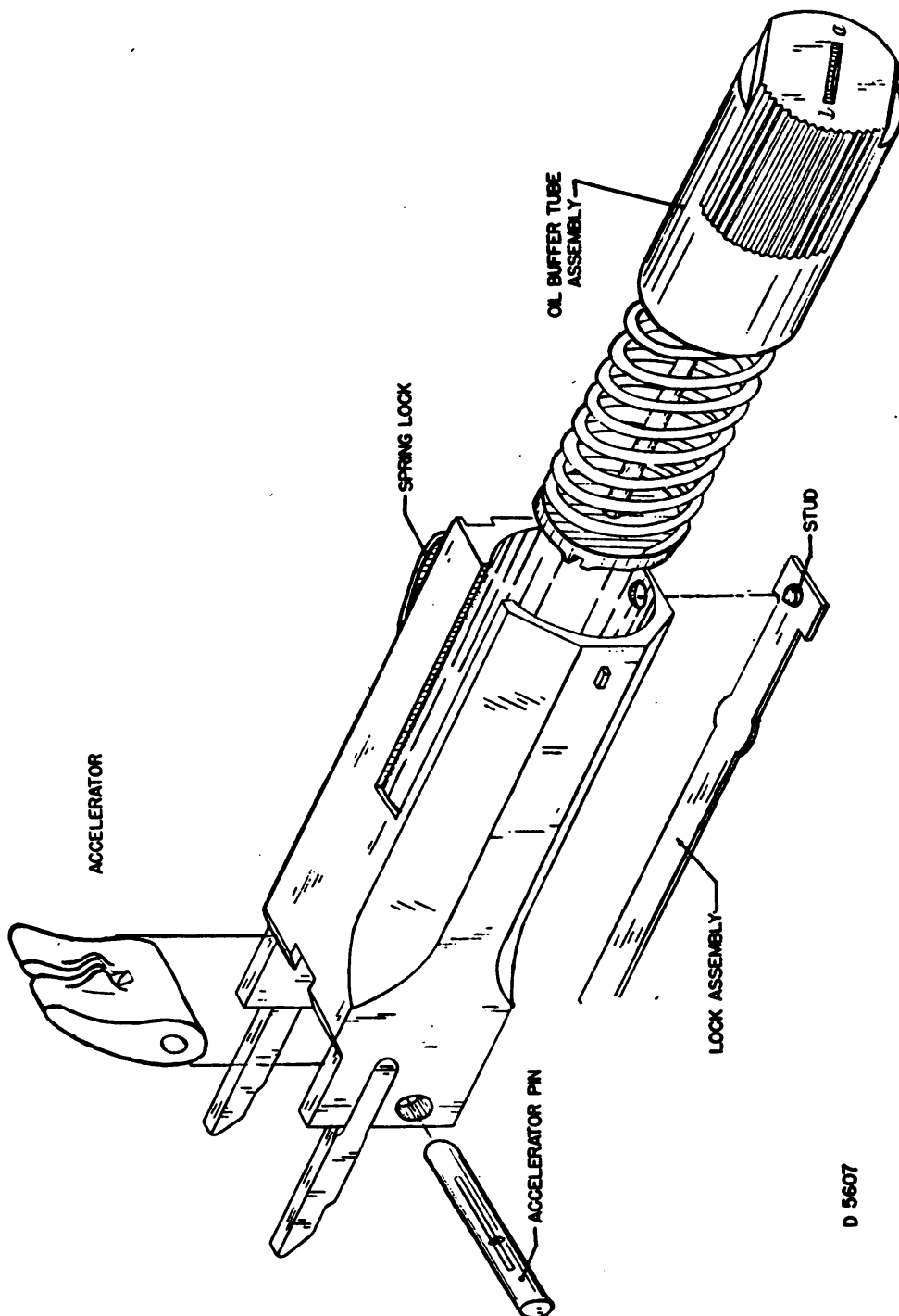


FIGURE 79.—Oil buffer group parts.

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- (6) Remove cover latch spring by lifting its front end out of slot in cover and sliding it forward.
- (7) Remove cover extractor spring by releasing its rear end from its seat in the cover extractor cam and sliding to the rear.



(8) Withdraw cotter pin from end of cover latch shaft and remove cover latch shaft assembly.

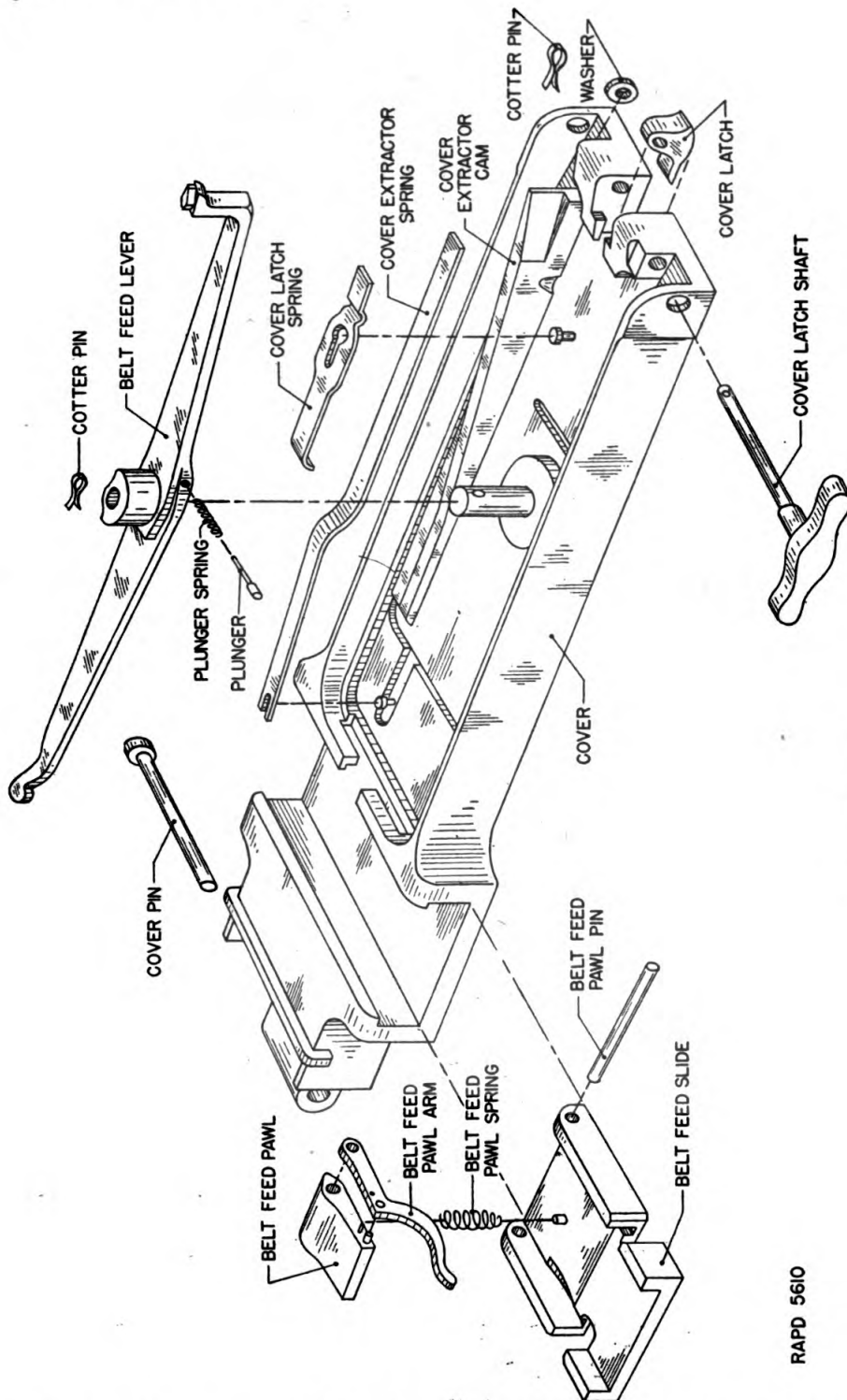


FIGURE 80.—Cover group parts.

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*e. Back plate group (fig. 81).—*(1) Drive out back plate latch pin being careful that the back plate latch spring does not fly out upon removal of back plate latch.

(2) Remove cotter pin, drive out latch lock pin, and remove latch lock and latch lock spring.

(3) Drive out trigger pin being careful that the trigger spring does not fly out upon removal of trigger and trigger spacer.

(4) Unscrew adjusting screw, remove adjusting screw plunger and adjusting screw plunger spring.

(5) Remove buffer disks and buffer plate through the rear end of the buffer tube.

*f. Casing group.*—(1) To prevent injury to rear sight leaf, the rear sight movable base and rear sight leaf assembly should be removed from the rear sight fixed base. Turn rear sight windage screw knob until rack on movable base is entirely free from windage screw, then lift assembly from movable base pivot. Lift off movable base tension spring.

(2) To remove side plate trigger assembly from casing, withdraw cotter pin from side plate trigger bolt and unscrew side plate trigger nut. To disassemble—

(a) Pull side plate trigger slide out of its guides in the side plate trigger housing.

(b) Drive out side plate trigger pin and remove side plate trigger cam and spring.

(3) To remove retracting slide assembly from casing, pull out locking wires and unscrew retracting slide bracket screws. To disassemble—

(a) Withdraw cotter pin from retracting slide bracket bolt. Unscrew retracting slide nut and remove bolt from retracting slide bracket.

(b) Withdraw cotter pin from retracting slide lever stud. Unscrew retracting slide nut and remove retracting slide lever stud washer. Remove retracting slide lever and retracting slide grip assembly from retracting slide lever stud. Remove retracting slide lever spring.

(c) Remove retracting slide from retracting slide bracket.

(d) The retracting slide stud can be removed from the retracting slide but this should not be done unless necessary for replacement as the stud is staked in place.

(4) Lift end of trigger bar pin lock from its seat in the side plate, rotate downward about 90° and pull out trigger bar pin. Remove trigger bar.

(5) Remove cotter pin from switch pivot nut. Unscrew nut and remove switch and switch spring.

(6) Draw belt holding pawl pin out to the rear, taking care that the belt holding pawl spring does not fly out upon removal of the pawl. Remove belt holding pawl and spring.

(7) Draw belt holding pawl pin, located on the opposite side of the feedway, out to the rear and remove link stripper and cartridge stops, front and rear.

(8) Unscrew front barrel bearing lock screw jam nut and front barrel bearing lock screw. The muzzle gland, muzzle packing ring, and barrel packing may now be removed but it is not recommended unless necessary for repair or to repack the barrel.

**Caution.**—The front barrel bearing must not be removed except when necessary for replacement. If it becomes necessary to do this, the front barrel bearing lock must be removed before unscrewing the front barrel bearing.

(9) The front end cap thread cover can be removed by unscrewing.

**88. Assembling.**—*a. Casing group.*—(1) Replace front end cap thread cover.

(2) If muzzle gland, muzzle gland packing ring, and barrel packing have been removed, replace them and screw muzzle gland lightly against ring and packing as the gland will be adjusted and locked in place after the barrel is assembled to the gun.

(3) Position link stripper and cartridge stops, front and rear, on right side of feedway and insert belt holding pawl pin.

(4) Place belt holding pawl spring in its seat in left side of feedway. Position belt holding pawl over spring, compressing spring to allow insertion of belt holding pawl pin. Insert belt holding pawl pin.

(5) Place switch and switch spring in position on left-hand side plate. Screw on switch pivot nut and insert cotter pin.

(6) Place trigger bar in its slot in top plate bracket so that hole in trigger bar is in line with hole in casing with long end of trigger bar to the front and the cammed surface down. Insert trigger bar pin with lock down and rotate lock into its seat in the side plate.

(7) Replace retracting slide stud if it has been removed from retracting slide. Stake retracting slide stud to retracting slide. Replace retracting slide in retracting slide bracket with stud on the slide to the front. Position retracting slide lever spring in its seat in retracting slide lever with large loop of spring over the hole for the retracting slide lever stud. Place retracting slide lever and spring on retracting slide stud with small loop of spring over retracting slide stop. Rotate retracting slide lever until it clears the stop. Depress lever making certain the large loop of retracting slide lever spring clears the collar of retracting slide lever stud. Replace retracting slide lever stud washer and nut. Replace cotter pin in retracting slide lever stud nut. Place retracting slide bracket bolt in its hole in retracting slide bracket. Screw on retracting slide bracket nut loosely.

(8) Place retracting slide assembly on right side of casing with holes in the slide in line with holes in the side plate. Screw in retract-

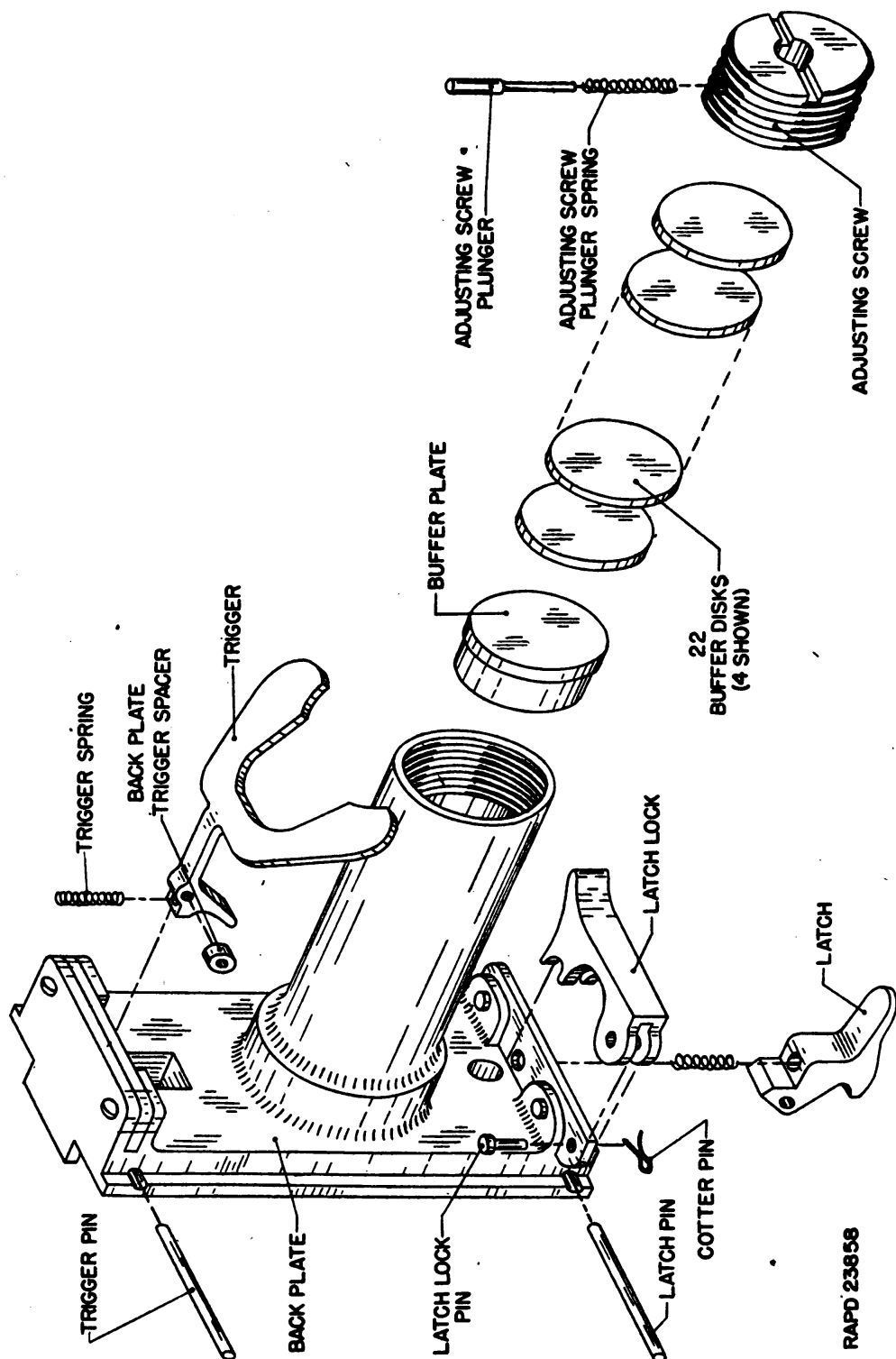


FIGURE S1.—Back plate group parts.

ing slide bracket screws and replace locking wires. Tighten retracting slide bracket nut and replace cotter pin.



(9) Seat side plate trigger spring in the side plate trigger housing. Position side plate trigger cam over the spring and insert side plate trigger pin. Insert side plate trigger slide in its guides in side plate trigger housing and push the slide forward into position.

(10) Place side plate trigger assembly on left side of casing, inserting the dovetailed end of housing into the forward slot in side plate. Adjust bolt to secure assembly to casing and tighten nut. Insert cotter pin in side plate trigger bolt.

(11) Place movable base tension spring over stud on rear sight base. Place rear sight movable base and rear sight base assembly over stud in rear sight base. Engage windage screw with rack of movable base. Center sight by turning windage screw until sight index mark on movable base is in line with zero mark on windage scale.

*b. Back plate group.*—(1) Insert buffer plate and buffer disks in buffer tube. Disks should be clean and free of rough edges and surfaces and should be assembled in the tube one at a time, being sure that each disk is firmly seated.

(2) Replace adjusting screw plunger and spring in adjusting screw. Insert adjusting screw in buffer tube and tighten.

(3) Replace trigger, trigger spacer, and trigger spring, and insert trigger pin.

(4) Replace latch lock spring and latch lock. Insert latch lock pin and cotter pin.

(5) Replace back plate latch spring and back plate latch and insert back plate latch pin.

*c. Cover group.*—(1) Insert cover latch shaft assembly in hole in cover and replace cotter pin.

(2) Place forked end of cover extractor spring over stud in cover and engage the other end of spring in slot in cover extractor cam.

(3) Place cover latch spring over stud in cover and slide forward, making certain that the rear end rests on the cover latch.

(4) Hold belt feed pawl with recess for belt feed pawl spring up and studs to the right. Place belt feed arm over studs on belt feed pawl with belt feed arm pointing to the right and holes in belt feed pawl and arm in alinement. Place belt feed pawl spring in its seat in pawl and position belt feed pawl in belt feed slide. Insert belt feed pawl pin. Insert belt feed slide, complete, in its guides in the cover, making certain that belt feed pawl arm is to the rear.

(5) Place belt feed lever plunger and spring in rear hole of belt feed lever. Insert toe of belt feed lever through slot in cover and engaging belt feed slide. Position belt feed lever so that it goes over

stud in cover, and at the same time compress belt feed lever plunger and spring so that they clear the side of the cover. Insert cotter pin in stud.

(6) Place cover assembly on trunnion block and insert cover pin. Insert cotter pin in cover pin.

*d. Barrel group.*—(1) Insert breech lock in its guides in barrel extension, making certain that bevel faces of breech lock are to the front with the double bevel on the top. Insert breech lock pin, taking care that both ends of pin are flush with sides of barrel extension.

(2) Replace barrel locking spring by sliding it into its seat in barrel extension.

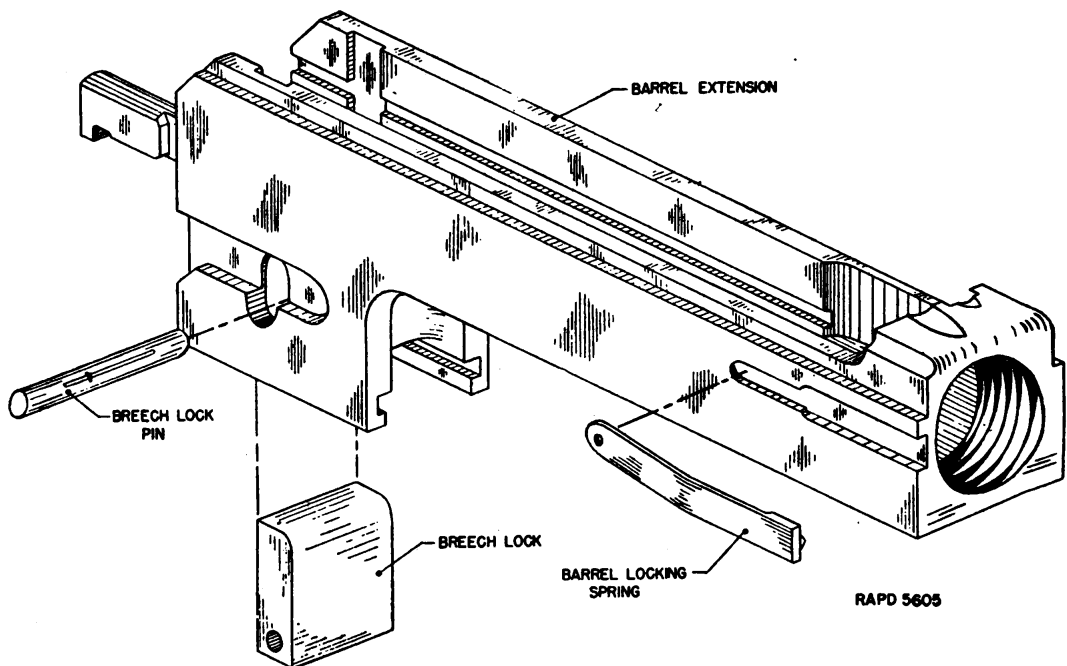


FIGURE 82.—Barrel extension group parts.

(3) Screw barrel into barrel extension.

*e. Oil buffer group.*—(1) *Assembling.*—(a) If the oil buffer tube has been disassembled, place oil buffer spring over oil buffer piston rod. Position oil buffer spring guide so that slot in guide is in line with pin on oil buffer piston rod. Press down on oil buffer piston guide so that oil buffer piston rod pin passes through slot in guide and rotate guide until recesses in the guide are alined with the pin in the rod. Allow pin to seat itself in recesses.

(b) Insert oil buffer body spring lock in its groove in the body and push forward.

(c) Position oil buffer tube lock spring over slot in oil buffer body with flanges of the spring over the enlarged cut in the slot. Depress

spring into the cut and slide forward, raising stud end of spring up and over the end of oil buffer to seat stud in hole in oil buffer body.

(d) Insert oil buffer tube assembly in oil buffer body and push forward as far as it will go. Place accelerator, with tips up and the rounded surface to the front, between depressors on oil buffer body and insert accelerator pin, taking care that both ends of pin are flush with the sides of oil buffer body.

(2) *Adjustment of oil buffer.*—(a) The oil buffer is so arranged that it is possible to adjust the speed of the firing of the machine gun. This is accomplished by turning the oil buffer tube the required number of clicks, depending on whether a high rate of fire is desired or a slower rate.

(b) Turning the buffer tube to the right tends to cut off or close the oil buffer which allows it to absorb more recoil and to reduce the rate of fire.

(c) Turning the buffer tube to the left allows the oil buffer to open and allows the oil to pass through larger throttling ports which results in an increased rate of fire.

(d) The oil buffer tube is turned by inserting a screw driver blade into the slot in the rear of the buffer tube through the hole in the back plate.

*f. Bolt group.*—(1) Assemble firing pin and firing pin extension and insert this assembly into firing pin hole in bolt with the notch of firing pin extension down. Push forward until striker projects through small hole in front of bolt.

(2) Seat sear spring in its recess in bolt. Insert sear in its guides in bolt. Press down on sear enough to allow sear slide to be inserted from left side of bolt. In inserting sear slide the bevel end should be inserted first and the V-cut in the sear slide should be on the bottom. When the cut on the sear slide is over the corresponding cam on the sear, release pressure on sear and the slide will be engaged.

(3) Insert pin of sear stop through firing pin extension and depress sear stop as far as it will go. With thin end of cocking lever, swing the spring end of sear stop into its recess in bolt.

(4) Insert cocking lever in bolt, the rounded nose on lower end of cocking lever to rear of the bolt so that it will properly engage the rear of slot in firing pin extension. Line up the hole in cocking lever with the holes in bolt and insert cocking lever pin from the left side.

(5) Cock by pressing forward on cocking lever. Turn cocking lever to the rear and press in on sear slide to release firing pin and test correctness of the assembly.

(6) Place bolt switch over bolt switch stud with enlarged portion of bolt switch to the front of bolt.

(7) If the ejector and ejector spring have been removed, replace them on the extractor and insert ejector pin. Holding extractor in an upright position, insert stud of extractor into the hole in the bolt and rotate downward, being sure that the flange on the extractor is under the collar on the bolt.

(8) If driving spring rod has been disassembled, place driving spring over driving spring rod and compress the spring enough to allow the driving spring rod collar to fall below the hole for the driving spring rod collar stop pin. Insert pin and peen the end of pin to prevent loss.

**89. Packing barrel.**—Remove barrel assembly from gun.

*a. To pack breech end.*—Unscrew packing adjusting ring and remove old rear barrel packing. Clean recess in barrel and insert new rear barrel packing. Smooth barrel packing until ends meet. Screw packing adjusting ring against barrel packing to hold it in place.

*b. To pack muzzle end.*—Unscrew front barrel bearing lock screw jam nut and front barrel bearing lock screw. Unscrew and remove muzzle gland. Remove muzzle packing ring and old front barrel packing. Clean out inside of front barrel bearing. Insert new front barrel packing and replace muzzle packing ring and muzzle gland. Screw muzzle gland lightly against ring and packing as the gland will be adjusted and locked in place after the barrel is reassembled in the gun.

*c. Reassemble barrel assembly* into gun being careful not to injure barrel packing.

*d. Adjust front barrel packing* (muzzle packing) by tightening or loosening muzzle gland, then lock in place with front barrel bearing lock screw and jam nut.

*e. Adjust rear barrel packing* (breech packing) by tightening or loosening packing adjusting ring. A packing ring adjusting wrench and a barrel holding wrench are provided for this purpose.

**90. Changing barrels.**—*a.* Open drain valve and drain water from water jacket into water chest or other suitable receptacle. Remove back plate, bolt, and driving spring assemblies. Remove barrel, barrel extension, and oil buffer assembly by pulling out to the rear. Separate old barrel from barrel extension and replace with new one. Reassemble barrel, barrel extension, oil buffer, bolt, driving spring, and back plate assemblies to the gun. Care must be exercised in removing and assembling the barrel in order not to disarrange the barrel packing. Make head space adjustment as outlined in paragraph 63. Close drain valve and refill water jacket with water. Adjust breech and muzzle barrel packing if necessary.



b. If it is necessary to keep water in water jacket when changing barrels, the following method can be employed: Remove back plate, bolt, and driving spring assemblies. Screw union caps to inlet and outlet openings of water jacket and lower muzzle of gun to prevent loss of water at the breech end. Hold a plug at muzzle of barrel. Withdraw oil buffer, barrel extension, and barrel assemblies to the rear. As the barrel is withdrawn, follow it with the plug and insert plug in hole in muzzle gland through which the barrel has been withdrawn. Place a plug or twisted patch in muzzle of new barrel. Separate old barrel from barrel extension and replace with new one. Reassemble barrel, barrel extension, and oil buffer assemblies into gun. When the muzzle of the new barrel passes through hole in muzzle gland, remove plug in the hole. Remove plug in muzzle of barrel and run a cleaning patch through barrel. Reassemble bolt, driving spring, and back plate assemblies into gun. Make head space adjustment as outlined in paragraph 63. Adjust breech and muzzle barrel packing if necessary.

## SECTION X

### SIGHTING AND FIRE-CONTROL EQUIPMENT FOR M3 AND M3E1 CARRIAGES

	Paragraph
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Quadrant, gunner's, M1 or M1918.....	92
Set, control equipment, automatic gun, antiaircraft, M1.....	93
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**91. Arrangement of sighting and fire-control equipment for M3 and M3E1 carriages.**—*a.* The principal sighting device for the M3 and M3E1 carriages is the sighting system M2. This system is used for direct aiming at aircraft or ground targets.

*b.* The sighting system includes two tracking telescopes mounted to move with the gun in azimuth and elevation. The azimuth and elevation handwheel operators follow the target through these telescopes, pointing the gun as required to keep the target centered on the cross lines in the telescopes.

*c.* Lateral and vertical deflections are determined by observation of the tracer stream during fire. These deflections are then applied to the gun by means of the antiaircraft automatic gun-control equipment set, M1. The effect is to shift the tracking telescopes laterally or ver-

tically, so that when the operator brings the telescope cross lines back onto the target, the gun will have been moved the necessary amount.

*d.* The control equipment set operates the telescope lateral and vertical deflection mechanisms through flexible shafts which connect to couplings in the carriage chassis. A 360° drive mechanism is provided in the carriage to prevent twisting of these flexible shafts as the gun is traversed.

*e.* A gunner's quadrant is provided for use in performing adjustments involving measurement of gun elevation.

**92. Quadrant, gunner's, M1 or M1918.**—*a. General.*—The gunner's quadrant is used for measuring the elevation or depression of the

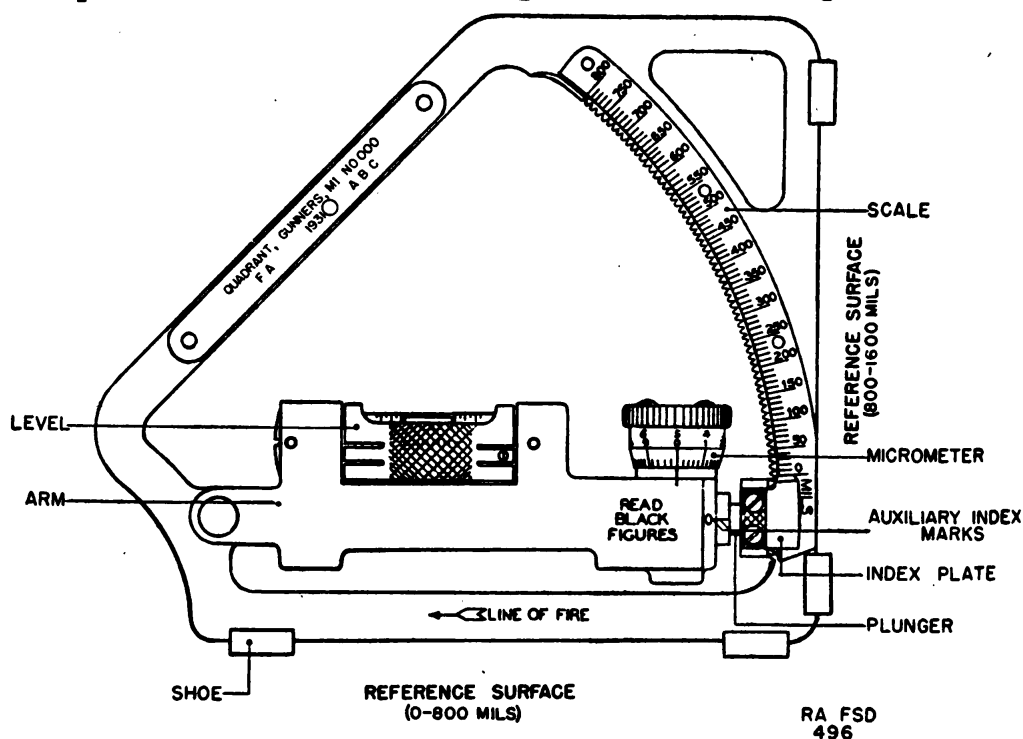


FIGURE 83.—Gunner's quadrant M1.

piece. The gunner's quadrant M1 (fig. 83) is the standard. The gunner's quadrant M1918 (fig. 84) is the substitute standard. Either quadrant may be furnished.

*b. Description.*—The quadrant includes a sector-shaped frame to which is pivoted an arm carrying a level. The frame has two scales with corresponding reference surfaces. One scale and reference surface are used for elevations from 0 to 800 mils, and the other for elevations from 800 to 1,600 mils. Notches on the frame which engage a plunger in the arm permit rapid setting of the arm in 10-mil steps. The level has a 10-mil smooth motion at each step to provide a fine indication supplementing the coarse scale reading. The method of

obtaining the fine indication is the principal difference between the two quadrants. The M1918 has a slightly curved arm with the level guide arranged to slide along the arm; the M1 has a micrometer motion.

*c. Operation.*—(1) To measure the elevation of the gun, place the proper reference surface of the quadrant on the leveling plates, parallel to the bore, with the associated arrow pointing in the direction of fire. Set the level to indicate zero on the fine scale. Disengage the plunger from the notches in the frame, lift the arm and slowly lower it until

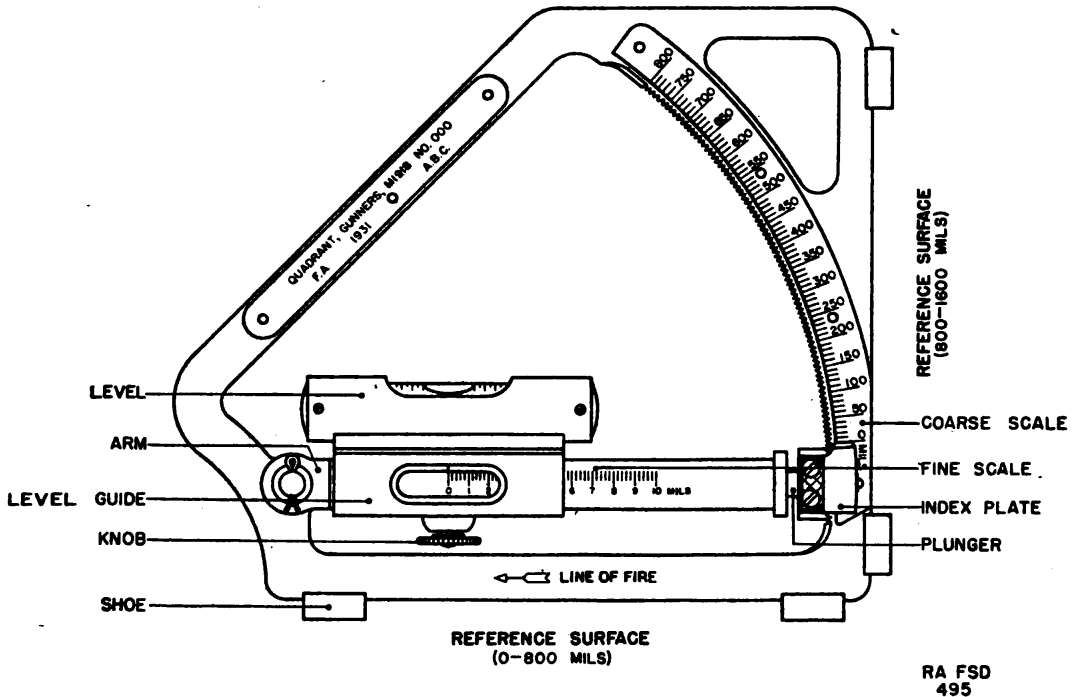


FIGURE 84.—Gunner's quadrant M1918.

the bubble is seen to pass through the central point. Allow the plunger to engage with the notches, then slide the level guide along the arm or turn the micrometer knob until the level bubble is accurately centered. Face the side of the quadrant which bears the arrow in use and read the coarse and fine scales. (In reading the M1 quadrant, a zero indication is read as "0 mils" when the auxiliary indexes are matched, or as "10 mils" when they are not matched. Read red or black figures according to the engraved instructions below the micrometer.) The elevation of the gun in mils is equal to the sum of the coarse and fine scale readings. Remove the quadrant from the gun before firing.

(2) To measure depression angles, proceed as above, but with the arrow pointed in the reverse direction.

(3) To lay the gun to a given elevation, set the coarse and fine scales to the required angle and place the corresponding reference surface on the leveling plates. Elevate the gun, then depress it until the level bubble is centered. Remove the quadrant from the gun before firing.

*d. Test and adjustment.*—No adjustment of the quadrant by the using arm is permitted. The zero indication may be verified by setting the quadrant to zero elevation, elevating or depressing the gun to center the bubble, then turning the quadrant end for end. If the bubble is not centered, determine the elevation or depression angle necessary to center it; one-half of this angle is the error, and a corresponding correction should be applied to all subsequent indications in the 0-800 mil region.

*e. Care and preservation.*—(1) Exercise particular care to prevent burring, denting, or nicking of the reference surfaces and of the notched portion of the frame.

(2) Do not leave the quadrant on the gun when firing.

(3) When not in use, keep the quadrant in the chest provided, with the shoes forming the reference surfaces lightly greased.

**93. Set, control equipment, automatic gun, antiaircraft M1.**—One automatic gun antiaircraft control equipment set, M1 (figs. 85 and 86) is furnished for each firing unit of two 37-mm automatic gun carriages M3 and M3E1. The complete set consists of the control box, eleven 50-foot flexible shafts (including one spare), and the necessary packing chests for control box and flexible shafts.

*a. Description.*—This control equipment set is a manually operated mechanical data transmission system, used to transmit corrected deflection data to the sighting systems of the guns. Vertical and lateral deflections are transmitted to the gun by flexible shafts connected to the control box of the set. This control box (fig. 87), which is not a computing device, contains differential drives whereby corrections may be added to the values received, and follow-the-pointer mechanisms, driven by handwheels, whence the corrected data are transmitted by the output flexible shafts to each sighting system.

*b. Operation.*—(1) Set up the control box. Carry the control box in its packing chest to the desired location, which should be on firm level ground. Release the four trunk bolts and remove the lid of the packing chest. Grasp the control box by the base and lift it from the chest. Remove the split pins holding the folding seat supports to the bottom of the chest. Unfold the seats upward and outward until the seats are substantially level and the holes in the projecting lugs of the horizontal seat supporting bars are alined with the holes in the blocks



at the ends of the packing chest. Insert the split pins in the holes. Slide the seats outward to the desired location, removable split pins being provided under each seat to permit this adjustment. Place the control box on the blocks ahead of the seats and screw the wing screws upward securely into the threaded holes in the base of the box. The appearance of the control box and packing chest, when ready to operate, is as shown in figures 85 and 86.

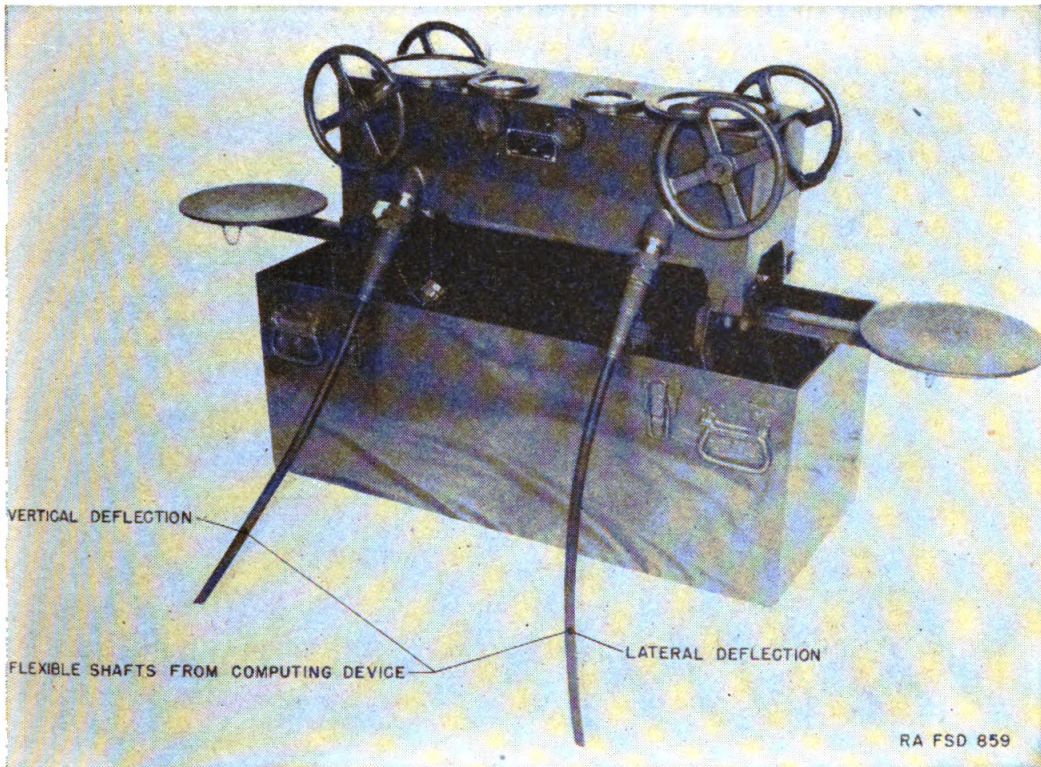


FIGURE 85.—Automatic gun antiaircraft control equipment set M1—input side.

NOTE.—Shafts marked “vertical deflection” and “lateral deflection” are not used.

(2) Set the control box indexes to “normal” (the positions shown in fig. 87), if they are not already in that position. First turn the deflection correction knobs until their respective indexes indicate zero, then turn the handwheels until the outer indexes indicate 500 (normal). If each inner index does not then match the outer index, unscrew the cover over the associated input coupling and turn the coupling as required to bring the indexes into coincidence.

(3) Set the counters of each sighting system to “normal.”

(4) Remove the required number of flexible shafts from their packing chests. The lateral deflection and vertical deflection drives of each gun sighting system require connection to one of the corresponding output couplings of the control box. When used with the 37-mm



automatic gun, only two of the four output couplings in each group are used. For runs longer than 50 feet, couple the required number of flexible shafts together, using the minimum number possible. To take up any excess of shaft length, lay the shaft in large arcs; sharp bends must be avoided as the increased friction resulting therefrom may cause incorrect transmission of data. Where flexible shafts are coupled together, or to a receptacle, screw the covers of the mating parts together to protect the threads.

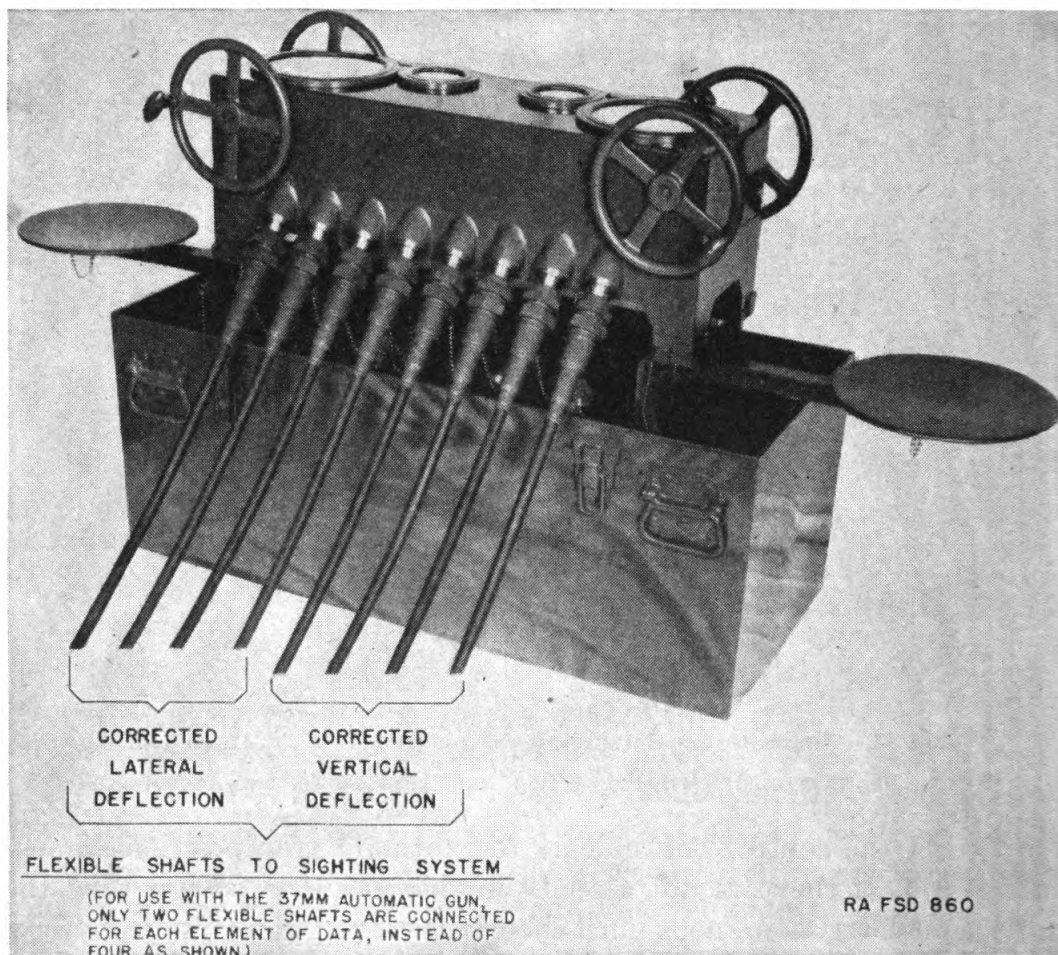
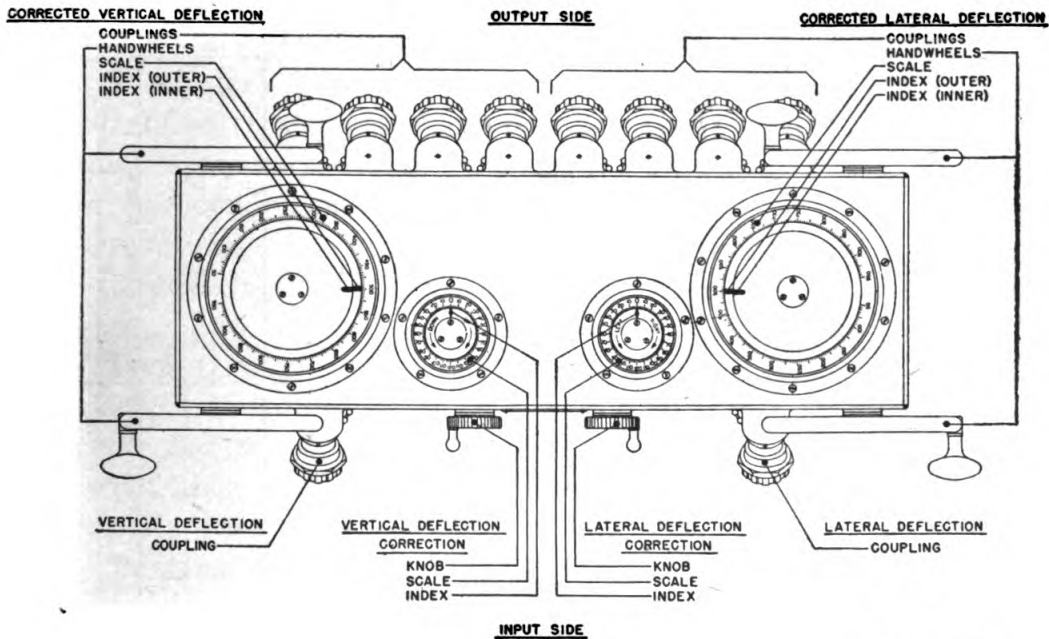


FIGURE 86.—Automatic gun antiaircraft control equipment set M1—output side.

(5) After the system has been completely connected, set in any required corrections to lateral and vertical deflections, using the associated knobs. Operate the handwheels so as to match their respective outer indexes continuously with the inner indexes.

(6) It is also possible to set corrected deflections, when known, on the control box directly. The values transmitted are those indicated by the outer index on the associated scale, the position of the inner index and the correction settings being disregarded.

(7) To prepare the set for traveling, remove the flexible shafts from the receptacles and replace all covers. Wipe all dust and water from the control box. Slide the seats to their innermost position. Place the seats and control box in the packing chest, following in reverse order the procedure given for setting up the control box. Grasp the control box only by the base when lifting. Wipe the flexible shafts clean from water and dirt and roll them up to the proper radius for packing in the chests. Each packing chest can hold four flexible shafts.



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FIGURE 87.—Control box, automatic gun antiaircraft control equipment set M1.

*c. Care and preservation.*—(1) Do not kink the flexible shafts nor bend them at a short radius. Exercise care to prevent them from being chafed, rubbed, or crushed.

(2) Keep the flexible shaft casing free from oil.

(3) Keep the ends of the couplings clean and lightly oiled using oil, lubricating, for aircraft instruments and machine guns. Keep the covers in place when the couplings are not in use.

(4) Ball bearings and gears are lubricated at assembly. Lubrication of these parts will be required only at long intervals and is to be performed only by ordnance personnel.

(5) Access by the using arms to the internal parts of the control box or flexible shafts for lubrication or other purposes is not permitted. Adjustment of stops by the using arm is not permitted.

(6) When placing a new control box in service make certain that the box is arranged for use with 37-mm antiaircraft gun matériel. Note the graduations on the corrected deflection scales, which should range from 50 to 950, and the location of the stops, which should function close to the maximum and minimum scale graduations.

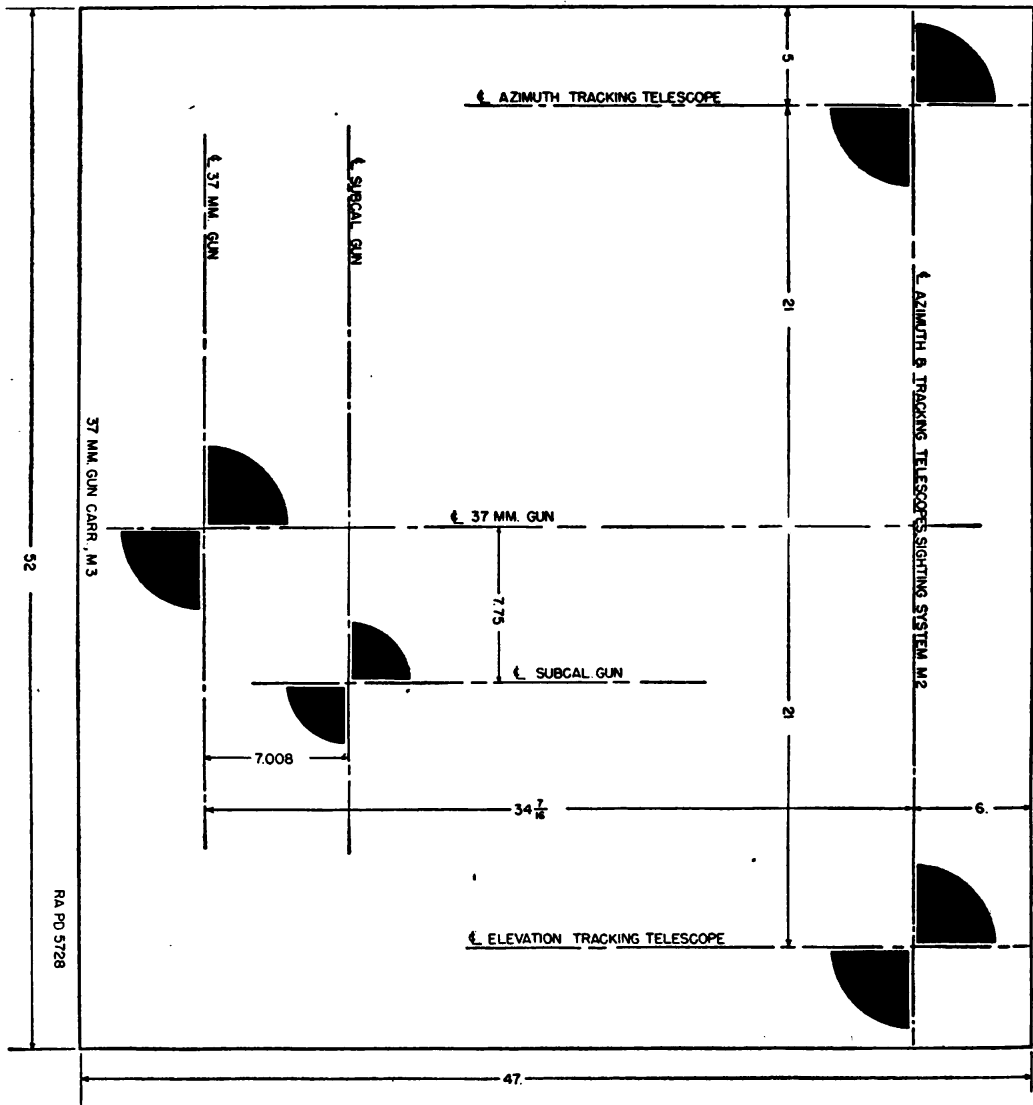


FIGURE 88.—Testing target.

(7) Do not connect a flexible shaft until the elements connected have been set to "normal." Never interconnect couplings not carrying the same element of data (vertical or lateral). When the flexible shafting is connected, never turn the handwheels at the control box so as to set a positive vertical deflection on the gun sight unless the gun is elevated about 20°. With the gun at zero elevation, an attempt to set in a positive vertical deflection lowers the deflection drive housing



until it is in contact with the case or handwheel brackets. Any attempt to lower the housing when it is in contact with the case will result in breaking the flexible shafting.

(8) Do not lift the control box by the handwheels.

**94. Bore sight.**—The bore sight is used to indicate the direction of the axis of the bore of the gun, for alinement and verification of sights. Each bore sight is composed of a breech element and a muzzle element.

*a. Description.*—(1) The breech bore sight is a disk which fits accurately in the breech chamber of the gun. It is provided with a handle for ready insertion and removal.

(2) The muzzle bore sight includes a quantity of black linen cord, to be stretched tightly across the muzzle vertically and horizontally in the score marks thereon, and a web belt to be buckled around the muzzle to hold the cord in place.

*b. Operation.*—(1) Remove the back plate and the lock frame. Place the breech bore sight in the breech opening. Attach the muzzle bore sight.

(2) Look through the aperture in the breech bore sight; the direction of the axis is indicated by the cord intersection.

*c. Care and preservation.*—Handle the breech bore sight carefully to prevent nicks and burs. Wind the cord and web belt into a compact bundle when not in use.

**95. Testing target.**—A testing target is under development for use with this matériel. When available, it may be used instead of an extremely distant object for alinement and verification of sights. Instructions for its use are given in paragraph 97*d*.

**96. System, sighting, M2, and telescope M7.**—One sighting system M2, (figs. 89 and 90) mounting two telescopes M7, is provided on each 37-mm automatic gun carriage M3, and is the means by which the gun is aimed in direction and elevation. The necessary settings of lateral and vertical deflection are introduced by means of the flexible shafts from the control equipment set through couplings in the carriage chassis.

*a. Description of sighting system.*—(1) The rear portion of the system is supported by a framework attached to the carriage and the forward portion rests on the elevating and traversing handwheel brackets.

(2) The two telescope holders, mounted on horizontal supports, are positioned laterally by means of the lateral deflection mechanism driven from the associated motion of the control equipment set.

(3) The telescopes, supports, and associated parts are positioned in elevation by means of counterweighted arms. These arms are driven by a differential gear, which combines the motions received from the elevating drive of the carriage and from the vertical deflection mechanism of the control equipment set.

(4) The values of the lateral and vertical deflection settings are indicated on counters. With "normal" deflection settings (500-mil

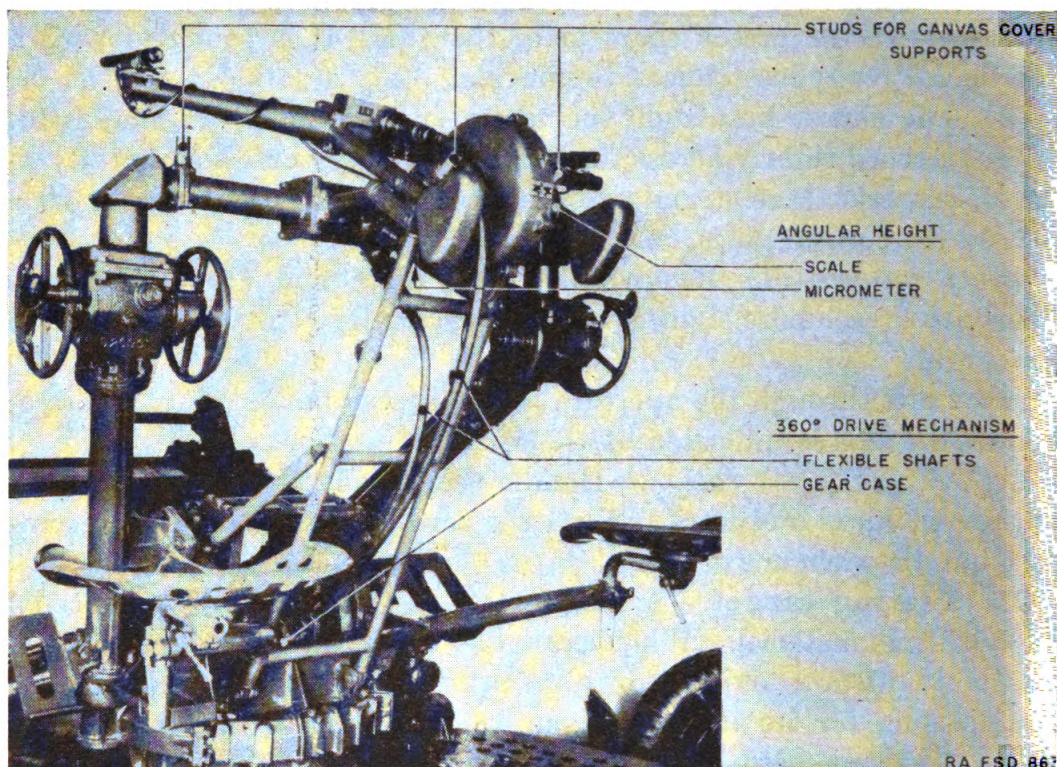


FIGURE 89.—Sighting system M2 with telescopes M7.

indications on both counters) the line of sight is alined with the bore of the gun. When deflections are introduced, both lines of sight are offset accordingly, still remaining parallel to each other. Lateral deflections are measured in the slanting plane through the target.

(5) Each telescope is clamped in a holder from which it is readily removed for traveling. The holder has a locating projection to insure correct vertical and horizontal positioning of the reticle lines.

(6) A 360° drive mechanism is provided to prevent twisting of the flexible shafts as the gun is traversed. This mechanism includes a gear case with four flexible shafts. Two of the shafts connect to the deflection mechanisms of the sight, and the other two shafts terminate in couplings mounted on the carriage to which the flexible



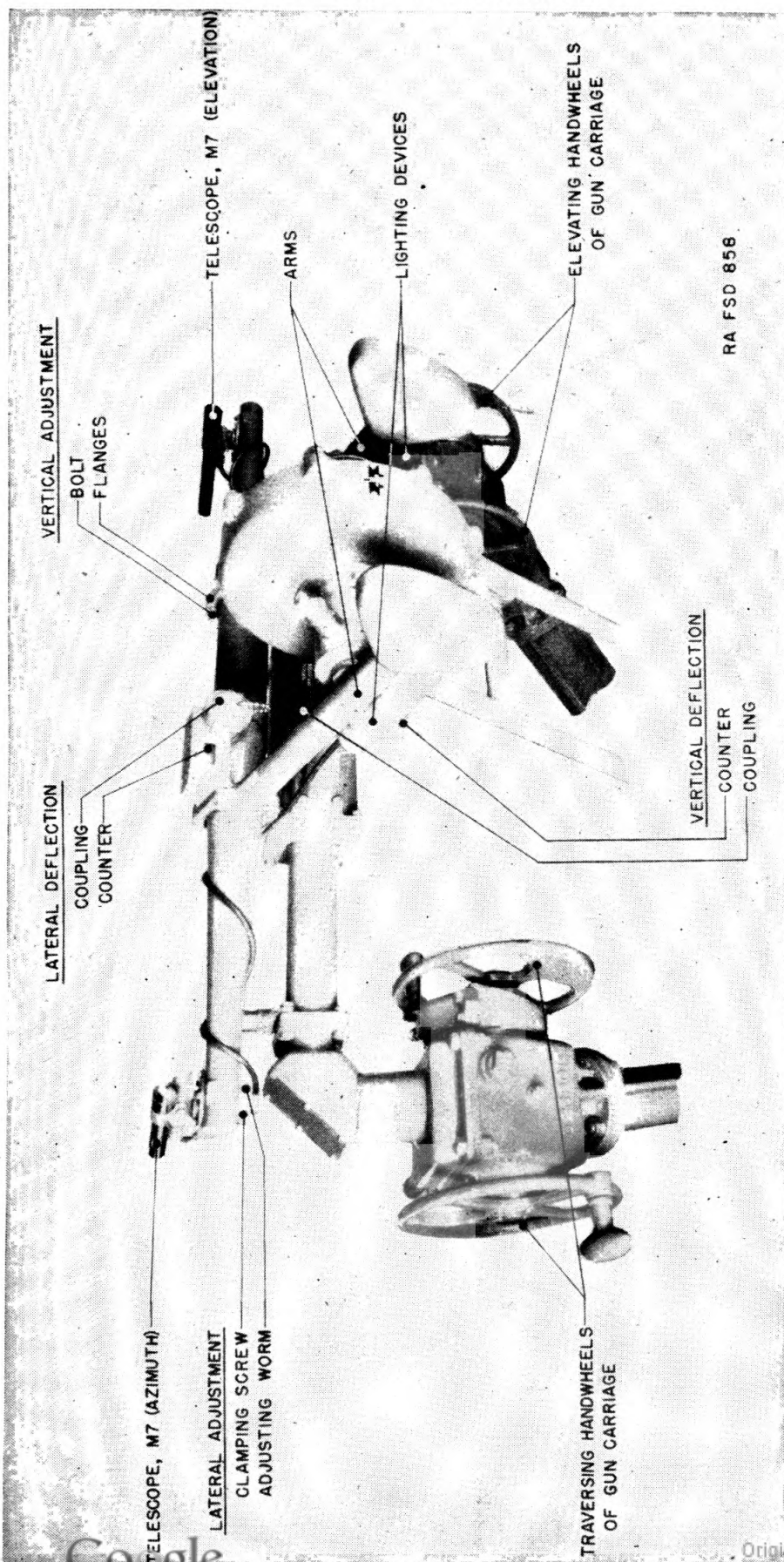
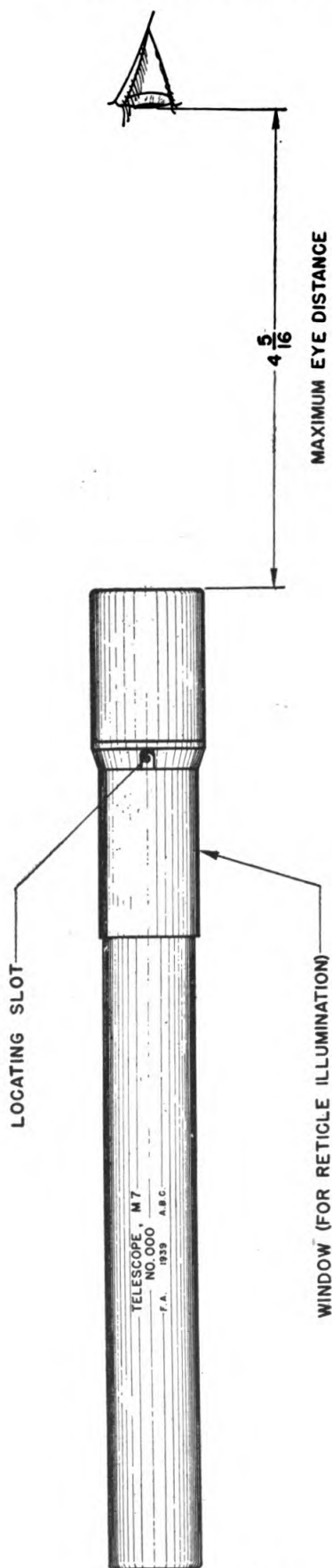


FIGURE 90.—Sighting system M2 with telescopes M7—location of controls and adjustments (360° drive mechanism not shown).



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FIGURE 91.—Telescope M7.



shafts of the control equipment set may be connected. The gear case, centrally mounted in the base of the carriage, contains differential gears which separate the motion of the deflection settings from the traversing of the mount. Unlimited traversing of the carriage is thus made possible.

*b. Description of telescope M7.*—This is a one-power erecting telescope (fig. 91) having a comparatively long eye-distance (over 4 inches) and narrow field of view ( $11^\circ$ ).

(1) The horizontal and vertical telescopes present slightly different reticle patterns. Each reticle has a vertical and a horizontal line, centrally located, with one line broken near the intersection. In each case, the locating slot of the telescope is positioned so that the broken line is the line not required for tracking.

(2) A dust cap, which consists of a leather cap for each end, connected by a strap, is provided for each telescope. One packing chest furnished with padlock and keys, with compartments for both telescopes, is provided for each carriage.

(3) The lighting device provided for each telescope includes a metal tube containing two standard flashlight cells, a switch, and a flexible cord with plug to fit in the lamp socket of the telescope holder. The metal tube snaps into a sleeve on the arm of the sighting system.

*c. Operation.*—(1) To place the system in operation, remove the canvas cover. Withdraw the pins and remove the cover supports from the studs. Remove the covers from the couplings in the front of the base of the carriage and turn the couplings so that both deflection counters indicate "normal" (500 mils). Set the control box to "normal" (par. 93b(2)) and connect the flexible shafts between the corresponding couplings of the control box and the sighting system. Clamp the telescopes M7 in their holders. The dust caps may be left on the telescopes until the system is ready for use. When necessary, illuminate each reticle by closing the switch in the front end of the lighting device.

(2) Operate the traversing and elevating handwheels of the mount so that the target appears continuously at the centers of the reticles.

(3) To place the system in the traveling position, remove the telescopes M7 from their holders, put on the dust caps, and place the telescopes in the packing chest. Be certain that the lighting device switches are turned to "Off"; the "Off" position of each is plainly marked. Place the cover supports on their studs and insert the pins to hold them in place. Put on the canvas cover.

*d. Disassembly and assembly.*—The main operations performed by the using arm are the application and removal of the cover supports,

the insertion and removal of the telescopes, incident to normal use, the removal of counters for adjustment, and removal and replacement of covers and screws for lubrication. The only other assembling and disassembling operations performed by the using arm are those necessary to renew the lamps or dry cells of the lighting device.

(1) To replace the dry cells, grasp the cap at the forward end of the lighting device and pull it forward, removing the tube containing the dry cells from the cylindrical sleeve on the arm. Unscrew the tube and replace the dry cells, placing both cells with their central terminals toward the cap. Use two standard flashlight battery cells, type BA-30. Screw the tube into the cap and replace it in the sleeve on the arm.

(2) To replace a lamp, remove the plug on the flexible cord from the lamp socket, then unscrew the socket, rendering the lamp accessible. Replace the lamp, using a standard No. 14 screw-base flashlight lamp, and return the socket and plug to their original positions.

**97. Tests and adjustments of system, sighting, M2, and telescope M7.**—The alinement of the sighting system should be verified frequently and adjusted if necessary.

*a. Alinement of telescopes with each other.*—The optical axes of both telescopes should be parallel at all elevation and deflection settings. Checks should be made with a number of combinations of these settings within the operating range by sighting on a celestial body or other extremely distant object. The left-hand telescope is adjustable laterally by means of the adjusting worm, the clamping screw first being temporarily loosened. The right-hand telescope is adjustable vertically at the point where the support flange is mounted; the bolts have sufficient clearance for this adjustment and may be temporarily loosened for this purpose. (Should the limit of adjustment at this point be reached, the flange on the left-hand side may be adjusted similarly.) When making these adjustments, approach the point from each direction and adjust for the minimum average error.

*b. Alinement of telescopes with the bore.*—The optical axes of both telescopes having been alined with each other as described above, their alinement with the bore may then be checked by bore sighting. Place the bore sights in the gun and bore sight on a celestial body or other extremely distant object. Set the lateral and vertical deflections to "normal" (500), approaching each first in one direction then in the other, and adjust the counters so that the "500" indication occurs when the mean position of the cross lines is on the object. When the lateral counter is set above 500, the gun should point to the right of the sights. When the vertical counter is set above 500, the gun should point above

the axis of the sights. To adjust a counter, remove the frame (vertical counter) or cover plate (lateral counter), with the counter assembled to the underside, turn the counter pinion until the desired reading is indicated and replace, taking care to mesh the gearing properly. The screws in the frame or cover plate may be temporarily removed by the using arm for making this adjustment.

*c. Adjustment of angular height indications.*—Although not ordinarily used in the operation of the sighting system, an angular height scale and micrometer are included (with systems of early manufacture, only). To verify these indications, level the carriage, set the lateral deflection to “normal,” and sight on a datum point of known angular height. The indication on the angular height scale (100-mil steps) and micrometer (1-mil steps) should agree with the angular height of the datum point; if not in agreement, the scale may be off-set, after temporarily loosening the screws in the elongated holes thereof, and the micrometer may be shifted after temporarily loosening the screws in the clamping disk. In the absence of a datum point of known angular height, the vertical deflection may be set at “normal” and the gun elevation, measured by a gunner’s quadrant, used instead.

*d. Use of testing target.*—If a testing target is available, it may be used for alinement and verification of sights in lieu of an extremely distant object or celestial body. Level the carriage, depress the gun to zero elevation using a gunner’s quadrant, and place the bore sights in position. Maintaining the target vertical in a plane perpendicular to the axis of bore at least 50 feet distant from the gun, place the testing target so that the axis of the bore falls on the corresponding aiming point of the target. Set the vertical and lateral deflections to “normal” (500 mils), approaching the setting first in one direction, then in the other. Should the target aiming points fail to appear at the centers of their respective telescope reticles, or the angular height scale and micrometer fail to indicate zero, the adjusting procedure outlined in preceding paragraphs is to be followed.

**98. Care and preservation of system, sighting, M2, and telescope M7.**—*a. General precautions.*—(1) This sighting system is rugged and suited for the purpose for which it has been designed. It will not, however, stand rough handling or abuse, and inaccuracy or malfunctioning will result from such mistreatment.

(2) Disassembly and assembly by the using arm is permitted only to the extent specifically authorized herein. Unnecessary turning of screws or other parts not incident to the use of the system is expressly forbidden.

(3) Keep the system in the condition indicated for traveling when not in use.

(4) Be certain that both sighting system and control box are set to "normal" before connecting flexible shafts.

(5) Stops are provided limiting the motion of the system in angular height. Avoid any attempt to travel past these stops as injury to the flexible shafts may result.

*b. Lubrication.*—(1) Ball bearings and worm drives are lubricated at assembly. Further lubrication of these will be required only at long intervals, and is performed by ordnance personnel.

(2) Keep the flexible shaft casings free from oil.

(3) The following elements will require the occasional application by the using arm of a few drops of oil, lubricating, for aircraft instruments and machine guns.

Element	Means of access
Elevating drive.....	Remove screw in sloping cover above elevating handwheel bracket.
Vertical deflection drive.....	Remove cover on front, ahead of vertical deflection coupling and counter.
Lateral deflection drive.....	Remove screw in housing, ahead of lateral deflection coupling and counter.
360° drive mechanism.....	Remove top cover.
Counter drive.....	Remove counters, as for adjustment. (Check indications when replacing.)
Couplings for flexible shafts..	Remove covers.

*c. Lighting devices.*—Remove the flashlight battery cells whenever the lighting devices are not in use. Chemical reaction set up in the cells as they become exhausted will cause the cells to swell, thereby making removal difficult and damaging the battery tube.

*d. Leather articles.*—Care and preservation of leather articles is covered in TM 9-850.

*e. Telescopes.*—(1) To obtain satisfactory vision, it is necessary that the exposed surfaces of the lenses and other parts be kept clean and dry. Corrosion and etching of the surface of the glass, which greatly interfere with the good optical qualities of the instrument, can be prevented or greatly retarded by keeping the glass clean and dry.

(2) Under no conditions will polishing liquids, pastes, or abrasives be used for polishing lenses and windows.

(3) For wiping optical parts use only paper, lens, tissue. Use of cleaning cloths on optical glass is not permitted. To remove dust, brush the glass lightly with a clean camel's-hair brush and rap the brush against a hard body to knock out the small particles of dust that cling to the hairs. Repeat this operation until all dust is removed.



With some instruments, an additional brush with coarse bristles is provided for cleaning mechanical parts; it is essential that each brush be used only for the purpose intended.

(4) Exercise particular care to keep optical parts free from oil and grease. Do not wipe the lenses or windows with the fingers. To remove oil or grease from optical surfaces, apply alcohol, ethyl, with a clean camel's-hair brush and rub gently with paper, lens, tissue. If alcohol is not available, breathe heavily on the glass and wipe off with paper, lens, tissue; repeat this operation several times until clean.

(5) Moisture due to condensation may collect on the optical parts of the instrument when the temperature of the parts is lower than that of the surrounding air. This moisture, if not excessive, can be removed by warming the instrument in a warm place. Heat from strongly concentrated sources should never be applied directly, as it may cause unequal expansion of parts resulting in breakage of optical parts or inaccuracies in observation.

## SECTION XI

### SIGHTING AND FIRE-CONTROL EQUIPMENT FOR M3A1 CARRIAGES

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Arrangement of fire-control and sighting equipment for M3A1 carriage	99
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**99. Arrangement of fire-control and sighting equipment for M3A1 carriage.**—*a.* This fire-control equipment is designed to operate as a coordinated system under the conditions encountered in short range antiaircraft fire on fast moving targets.

*b.* Gun pointing data originate at the antiaircraft director M5. The director determines the target position in space from the angular position of two tracking telescopes with which the operators follow

(track) their target, one telescope giving the horizontal position or azimuth, and the other telescope giving the vertical angle or elevation. Ranges are estimated by the range setter at the director and may be adjusted quickly from observation of the tracer stream during fire. Smooth and accurate tracking at high angular rates of travel is made possible by use of a system of tracking known as aided tracking. The director produces firing azimuth (angle of train) and quadrant elevation data for transmission to the gun.

*c.* The remote control system M1 points the gun in azimuth and elevation according to the controlling data furnished from the director. The system includes electrical and hydraulic power equipment (oil gears) mounted on the carriage and connected to the traversing and elevating mechanisms.

*d.* Electric power to operate the director and the power mechanisms for remote gun control is supplied by a gasoline-electric a-c generating unit M5.

*e.* Direct fire sights are mounted on the gun carriage. These sights are provided to adapt the gun for use against mechanized forces and other ground targets, and to enable the gun to be used when the director is not available.

*f.* A gunner's quadrant is provided for use in performing adjustments involving measurement of gun elevation (par. 92).

**100. Director, antiaircraft, M5.**—The antiaircraft director (figs. 92 and 93) is an instrument which computes the data for directing the fire of antiaircraft guns. The antiaircraft director M5 is used with the 37-mm antiaircraft gun carriage M3A1. Data calculated by the director are transmitted and applied to the guns by means of the remote control system M1 with electric power supplied by the generating unit M5. The director is also applicable to 40-mm antiaircraft gun matériel.

*a.* (1) The director requires three operators: a range setter, an elevation tracker, and an azimuth tracker.

(2) The director operates within the following limits:

Azimuth	No limits
Present elevation—electrical stops	—5° to 85°
—mechanical stops	—12° to 96°
Azimuth—maximum angular rate	20° per second
Elevation—maximum angular rate	20° per second
Range—37-mm	2,700 or 2,800 yards (depends on range scale used)



*b. Description.*—(1) The director mechanisms are mounted in a metal case which in turn is mounted on a tripod M7. Two elbow tele-

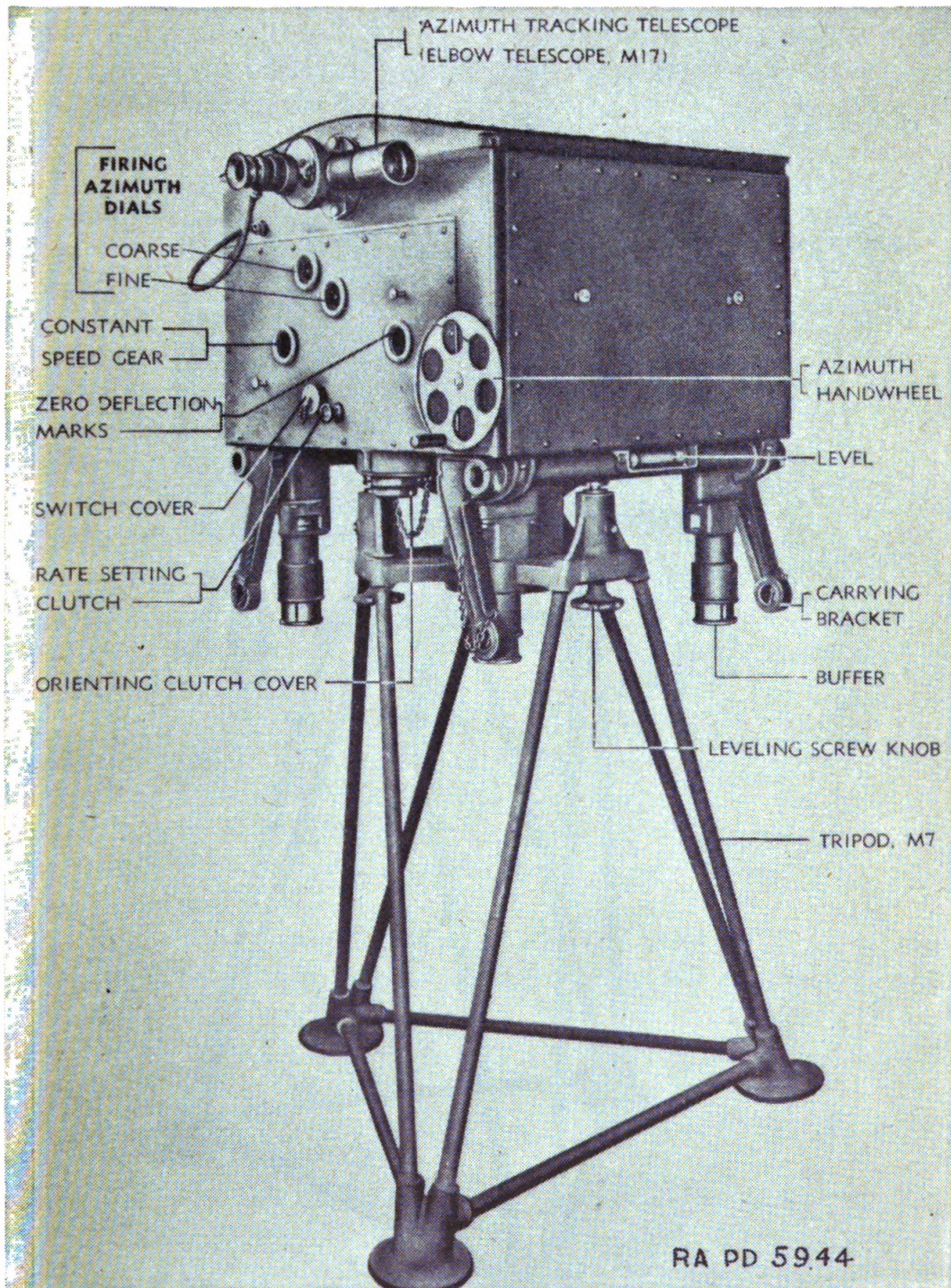


FIGURE 92.—Antiaircraft director M5—front and right side.

scopes M17, one on each side of the instrument, are mounted on a shaft passing through the director case. Carrying brackets and bars for



lifting and transporting the director, and buffers for supporting the director when it is not mounted on the tripod, are provided.

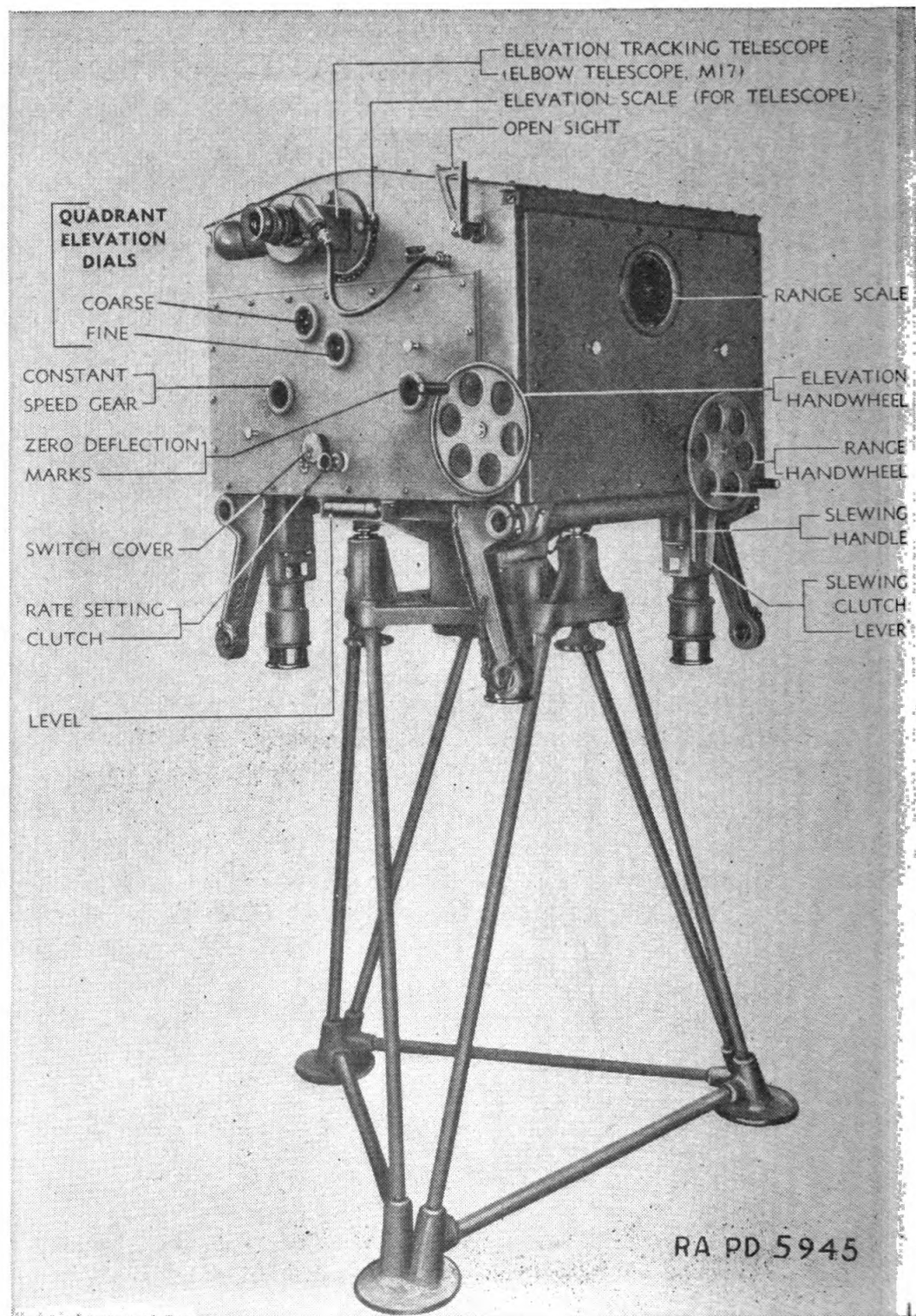


FIGURE 93.—Antiaircraft director M5—rear and left side.



(2) Operating controls which consist of a rate setting clutch, a switch, and a handwheel, are arranged on the right and left sides for the azimuth tracker and elevation tracker, respectively. A handwheel which is on the backplate is for the range setter. The front panel has no controls. A slewing clutch for rapid traverse of the director, and an orienting clutch for use in orienting the director with respect to the gun, are contained in the base of the director.

(3) The elbow telescope M17 is an 8-power, erect image telescope, having a field of view of 6°. It is provided with a diopter scale and adjustment for focusing, and four filters for use under different light conditions. The telescope is mounted to the flange on the telescope shaft by three thumbscrews.

(4) The open sight (fig. 93) is connected to the elevation tracking telescope by a linkage within the director, so as to follow the telescope motion and indicate the telescope field of view. Telescope elevation in degrees is shown by a scale near the elevation tracking telescope.

(5) The rate setting clutch near the tracking handwheel selects either aided tracking (clutch knob pushed in) or direct tracking (clutch knob pulled out).

*c. Accessories.*—Related equipment supplied with the director consists of a packing chest, canvas cover (carried in packing chest), accessory chest, and tool chest.

(1) The packing chest is a large wooden box used for storing and transporting the director. Two supports on the floor of the chest are provided for mounting the telescopes. Carrying bar brackets are attached to each end of the body. The carrying bars are the same bars that are used for lifting and carrying the director. Normally the bars are kept assembled to the chest.

(2) The canvas cover fits over the director with the telescopes in place. It is used to protect the director for short periods when it is mounted on the tripod.

(3) One accessory chest, containing spare parts, is issued with each two directors.

(4) One tool chest, containing tools, spare parts, and instruments, is issued with each two directors.

**101. Director operation.**—*a. Mounting and leveling the director.*—(1) *Set up the tripod.*—Set up the tripod on an approximately level spot and embed the feet of the tripod firmly in the ground. If the feet are not embedded to the depth permitted by the guards, the director will not remain level and the telescopes on the director will be located too high for comfortable operation. If the tripod is set up on a concrete or wooden floor, recesses should be provided for

the points on the feet so that the guards will bear the weight of the tripod and director.

(2) *Mount the director on the tripod.*—Release the spring detents on the carrying bar brackets of the director and swing the brackets up into position. Insert the carrying bars into the holes in the brackets and lift the director onto the tripod, then lower it carefully into position so that the three bushings in the housing slip down over the three plungers on the tripod. Care must be exercised not to jar or bump the director.

(3) *Level the director.*—Rotate the director by means of the slewing handle until one of the sides carrying a level is parallel to the line between two leveling screws. Adjust these two leveling screws to center the level bubble. Adjust the third leveling screw to center the bubble in the second level and then readjust the first two screws for any error caused by adjusting the second level.

(4) *Check the leveling.*—Traverse the director and note at approximately each quarter revolution any deviation of the level bubbles from the center. If the bubbles move off the center more than one division, repeat the leveling operation described above until satisfactory leveling is obtained. Accurate leveling is essential, as any error in leveling will cause a corresponding error in the elevation data transmitted to the gun.

b. *Electrical connections.*—Check to see that all switches on the director and the main power switch at the generating unit are in the *off* position. Remove the plug from the receptacle in the bottom of the director and insert the plug on the cable from the gun junction box. Turn the cable adapter to lock the plug in the receptacle.

c. *Orientation, preliminary.*—(1) With the main power switch at the generating unit *off*, rotate the range handwheel (on the rear panel) until the range index indicates against the first graduation on the range scale.

(2) Push in the rate setting clutch on the azimuth side of the director and rotate the azimuth handwheel until the zero deflection marks on the deflection gear and pointer are in alinement, as seen through the right-hand window. Pull out the clutch.

(3) Push in the rate setting clutch on the elevation side of the director and rotate the elevation handwheel until the zero deflection marks on the deflection gear and pointer are in alinement, as seen through the right-hand window. Pull out the clutch.

d. *Orientation in elevation.*—(1) With the main power switch at the generating unit *off*, set the telescopes to the elevation of the gun, within plus or minus 10°, by means of the elevation handwheel. The

gun elevation is shown by painted index lines on the right gun trunnion. When matched, the lines indicate a gun elevation of  $30^{\circ}$ . When the main power switch is subsequently turned on, the gun will line up to the same elevation as the director telescopes.

(2) If the director telescopes and the gun are more than  $10^{\circ}$  apart when power is turned on, the gun will line up to a false position which will be  $20^{\circ}$  or a multiple of  $20^{\circ}$  out of register.

(3) The director and gun must be kept level at all times to maintain the orientation in elevation.

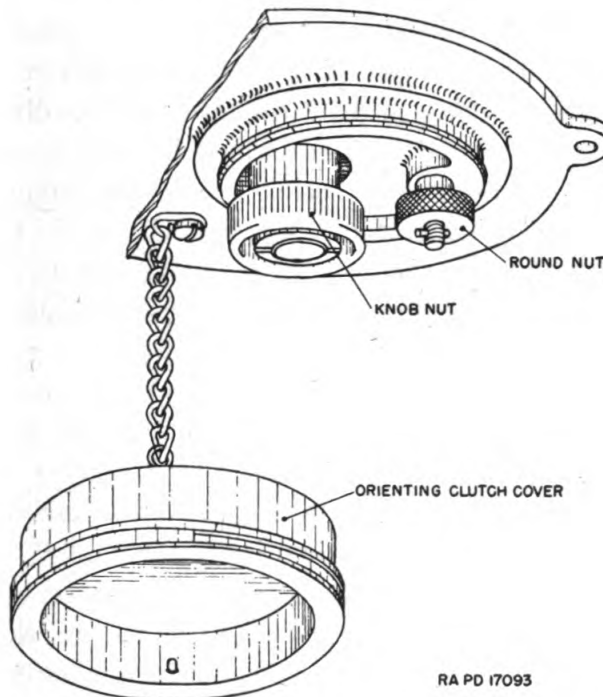


FIGURE 94.—Orienting clutch cover for adjustment.

*e. Orientation in azimuth.*—Turn power on at the generating unit. Pull the azimuth oil gear clutch operating handle (on the gun) to the rear and traverse the gun until it points in the same direction as the director telescopes, then push the operating handle forward, energizing the remote control system. Traverse the director until the gun is directed on a distant reference point. Unscrew the orienting clutch cover under the azimuth side of the director (fig. 94). Lock the transmitters by screwing up the small knurled round nut, and disengage the orienting clutch by unscrewing the large knurled knob. Grasp the slewing clutch and rotate the director until the telescopes are aligned on the reference point. Screw the large knob up tight, and release the transmitters by loosening the small nut. Replace the orienting clutch cover. Check the orientation by traversing the direc-

tor to bring the gun on at least one other reference point; the gun and director should still point in the same direction. The dials will register an arbitrary azimuth, not necessarily the true azimuth of the line of sight. (See par. 106 for orientation of the remote control system.)

*f. Tracking operations, picking up the target.*—On the approach of a probable target the azimuth and elevation trackers turn on both power switches. The range setter releases the slewing clutch and, with the assistance of the elevation tracker, alines the open sight on the target. He then sets in an opening range by rotating the range handwheel until the desired range is indicated on the range dial.

*g. Tracking the target.*—(1) The elevation tracker alines the telescope on the target and then pushes the rate setting clutch in sharply. By manipulating the elevation handwheel he sets in such a rate that the horizontal cross line on the reticle tracks the target smoothly.

(2) Simultaneously the azimuth tracker alines his telescope on the target and then pushes the azimuth rate setting clutch in sharply. By manipulating the azimuth handwheel the tracker sets in such a rate that the vertical cross line on the reticle tracks the target smoothly.

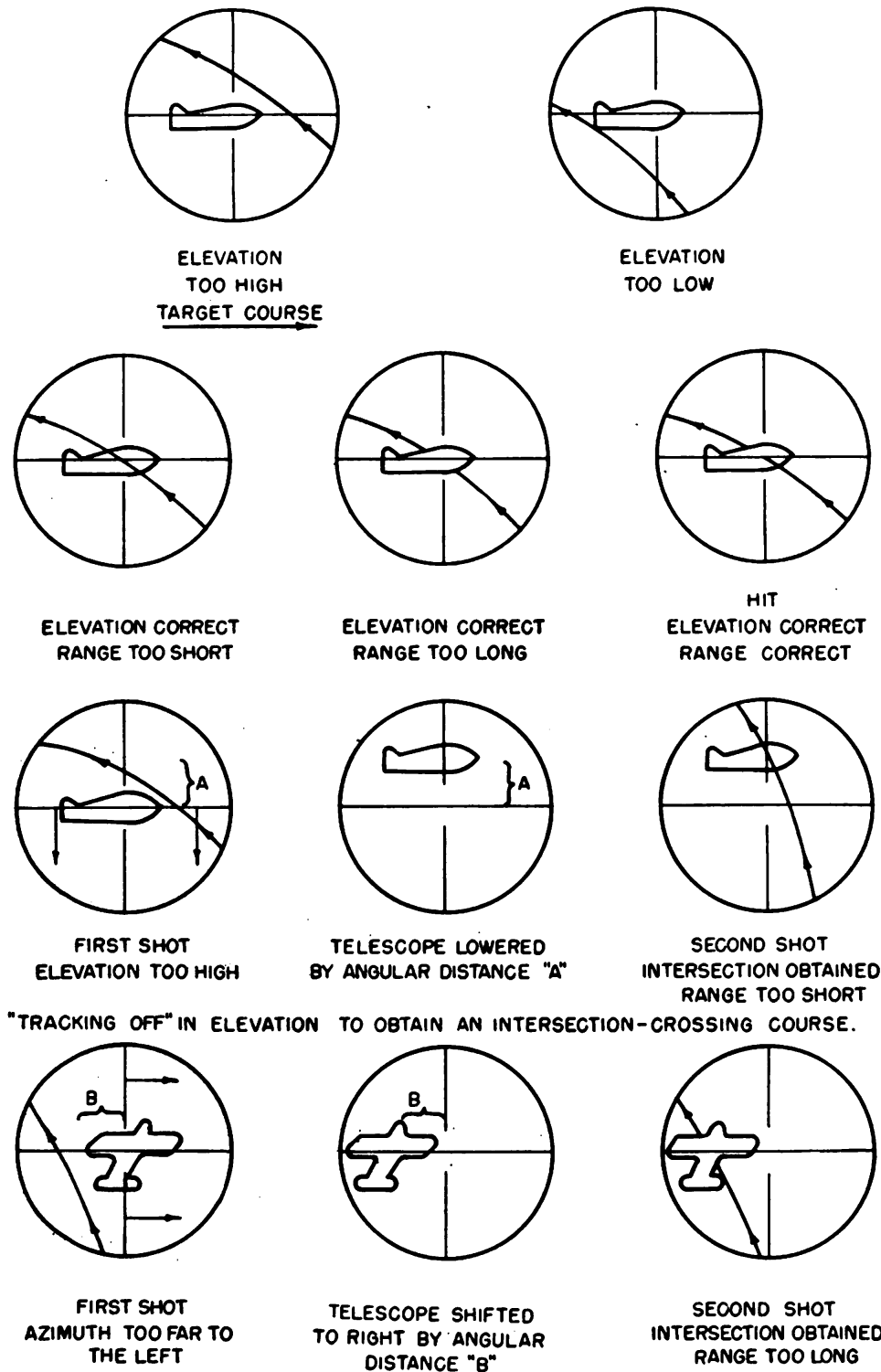
(3) The range setter observes the tracer stream and makes corrections in range to pass the trajectory curve through the target. The trackers can also make small corrections by tracking slightly off the target, in accordance with the practice of the using service.

(4) Tracking operations are shown in figure 95.

*h. Changing targets.*—When the command is given to track a different target, the two trackers immediately aline the marks on the deflection gears and indexes and then pull out the rate setting clutches. The range setter alines the director on the new target, using the slewing clutch to permit rapid traverse, and sets in a new opening range. The two trackers then follow the same procedure in picking up the target and setting new rates as described above.

*i. Operation after tracking.*—To cease tracking, the elevation and azimuth trackers aline the marks on the deflection gears and indexes, pull out the rate setting clutches, and turn their power switches off. The range setter sets the range dial at 500 yards (or other estimated target pick-up range). The azimuth tracker traverses the director to the general direction of the approach of enemy aircraft, and the elevation tracker sets the telescopes to 30° elevation (or any other selected elevation, provided the same setting is used at both the gun and director).





"TRACKING OFF" IN ELEVATION TO OBTAIN AN INTERSECTION-CROSSING COURSE.

"TRACKING OFF" IN AZIMUTH TO OBTAIN AN INTERSECTION-INCOMING COURSE.

RA PD 5946

FIGURE 95.—Antiaircraft director M5—adjustment of fire by observation of the tracer stream.

*j. Tracking cautions.*—(1) When slewing the director, the deflection gears should be set to zero deflection and rate setting clutches pulled out.

(2) Before shutting off power, set the deflection gears to zero. Verify that the deflection gears are set to zero before turning the power switches on.

(3) Push in the rate setting clutches as soon as possible after picking up the target. The rate computing mechanisms do not operate until these clutches have been pushed in.

(4) Do not slew the director by pushing on the case; use the slewing handle.

(5) While tracking, make changes in track by a smooth, even motion of the handwheels; sudden, jerky changes will cause the gun to hunt and pass the settings determined by the director.

(6) The handwheels should not be brought sharply against their stops and no attempt should be made to force them beyond the limits of their motion.

*k. Setting-up cautions.*—(1) No attempt should be made to lift the director in any other way than by means of the carrying bars provided.

(2) Extreme care must be exercised in locating and setting up the tripod to eliminate all possibility of its shifting, sliding, or tipping when the director is placed on it. The tripod legs must be firmly embedded in the ground so that once the director is placed on the tripod and leveled it will remain in a level position.

(3) When placing the director on the tripod, lower it carefully into position. Do not drop it, because to do so might damage the director mechanisms or the threads on the leveling screws.

(4) When lifting the director from the tripod, lift it vertically several inches to clear the tripod plungers.

(5) All electrical switches must be turned off when inserting or removing the cable plug from the receptacle in the bottom of the director.

(6) Before placing a new director in service, verify that the director has been prepared for use with 37-mm antiaircraft gun matériel, as shown by the markings on the range scale.

(7) Range scales are graduated for different values of muzzle velocity (2,400, 2,450, 2,500, 2,550, 2,600 feet per second), depending on the degree of wear of the gun. For accurate results, the scales should be changed as the gun wears (par. 104). Change of range scales is to be performed only by qualified personnel.

*l. Packing and transport.*—The director is built to withstand all normal service conditions but unduly rough handling should be

avoided. If the director is to be transported any distance, it should be placed in the packing chest. Prepare it for transport as follows:

(1) Remove the light cable plugs from the receptacles on the director case and wrap the cables around the eyepiece section of the telescopes.

(2) Remove the telescopes from the director and attach them to their supports in the bottom of the packing chest.

(3) Set the deflection gears to zero deflection. Pull out the rate setting clutches.

(4) Tie the handwheels together to prevent creeping of the gears.

(5) Put the canvas cover on the director.

(6) Swing the carrying brackets up, insert the carrying bars, and secure them with the pins attached to the carrying brackets. Lift the director off the tripod and lower it carefully into the packing chest. In removing the director from the tripod, it must be lifted vertically several inches to clear the plungers on the tripod. The director will rest on its buffer supports when placed in the chest.

(7) Remove the carrying bars from the carrying brackets and insert them in the carrying brackets on the chest. Insert the pins to secure them.

(8) Carefully slip the lid of the chest down over the director and secure it by means of the metal strips and screws. Matching arrows, painted on the two parts of the chest, indicate the proper alinement of the two parts.

(9) The packing chest should never be turned on its side or lifted by any other means than by the carrying bars which should be secured to the brackets by means of the pins provided.

**102. Director test and adjustment.**—The tests described below should be made at frequent intervals by operating personnel to ascertain whether or not the director is functioning properly. Tests are performed with power off unless otherwise noted. Any adjustments necessitating removal of the director cover plates are to be made only by qualified personnel (par. 113). Instructions for making such adjustments are not given in this manual. The only adjustments operating personnel are permitted to make are the adjustments of the open sight and the levels.

*a. Range stops.*—Push the rate setting clutches in and aline the lateral and vertical zero deflection marks. Pull the rate setting clutches out. Rotate the range handwheel between its limits in both directions. The range dial index should travel up to or slightly beyond the range scale limits.

*b. Deflection stops.*—The same procedure applies for both elevation and azimuth deflection stops. Set the range dial index to the vertical

reference graduation. Push the rate setting clutch in. Aline the zero deflection marks and note reading on the dials. Rotate the handwheel first in one direction and then in the other until it engages its stops. The movement in both directions should be the same.

*c. Electrical cut-out.*—Push the rate setting clutch in and aline the zero deflection marks in the elevation unit. Pull the clutch out. Turn power switch on. Elevate and depress the telescope by rotating the elevation handwheel. The electrical cut-out should operate at approximately 85° elevation and 5° depression.

*d. Constant speed motors (for variable speed mechanisms).*—Set the range scale index to the vertical reference graduation. Push the rate setting clutch in, set in a deflection, and then pull the clutch out. If testing the elevation motor, set the elevation dial to allow sufficient travel before the cut-out operates. Switch on power. Check the direction and rate of rotation of the motor by observing the white mark on the constant speed gear through the left-hand window. The gear should rotate in the direction of the arrow on the gear at a rate of 20 revolutions per minute. Tolerance for 20 revolutions is 0.5 second.

*e. Torque amplifier and gear drives.*—(1) See that the large knob under the orienting clutch cover is screwed up tight, and see that the rate setting clutch is pulled out. Turn azimuth or elevation handwheel steadily in either direction. The respective dials should record movements of handwheels without sign of slip. If dials fail to record movements of handwheels, it indicates excessive friction in the internal gearing.

(2) Set range index to the vertical reference graduation. Push the rate setting clutch in and aline the zero deflection marks. Switch on power. Alter the deflection smoothly from zero to maximum by turning the handwheel at an even rate. The director should traverse or the telescopes elevate smoothly with increasing speed until maximum deflection is reached. Return the deflection setting to zero and repeat the test in the opposite direction. If the dials do not move smoothly, the fault may be due to too light spring adjustment in the variable speed mechanism, to a faulty torque amplifier, or to chatter in the worm drive of the constant speed motor.

*f. Rate setting clutches.*—Set in the maximum range permitted. Push the rate setting clutch in and aline zero deflection marks. Pull the clutch out. Dials should not have moved.

*g. Zero setting of lateral deflection.*—Push the rate setting clutch in and aline the zero deflection marks. Turn power switch on. If the dials creep, turn the azimuth handwheel until they remain stationary.



Rotate the range handwheel slowly between the limits of its stops. The dials should remain stationary. Movement of the dials indicates that the pivoted deflection arm is not truly vertical when the ball is in the center of the constant speed disk.

*h. Zero setting of vertical deflection.*—Tests for the zero setting of the vertical deflection and the superelevation setting cannot be made without removing the left-hand cover plate, and therefore cannot be made by operating personnel.

*i. Parallelism of telescopes.*—(1) For this test a testing target with two pairs of cross lines is necessary. The points of intersection of the cross lines must be parallel to the telescope shaft, must be in the same horizontal plane when the target is set up, and must be the same distance apart as the optical axes of the telescopes (29.412 inches). The testing target should preferably be set up at a distance of 100 yards or more from the director.

(2) Traverse the director until the vertical cross line in the azimuth telescope falls on the right-hand vertical line on the testing target. Elevate or depress the telescopes until the horizontal cross line in the elevation telescope falls on the left-hand horizontal line on the testing target. If the telescopes are in adjustment, the intersections of the cross lines in both telescopes will fall on the intersections of the cross lines on the testing target.

*j. Open sight.*—Align the elevation telescope on a distant aiming point. Sight through the open sight to check its adjustment. If it is not aligned on the aiming point, loosen the thumbscrew on the sight and rotate it on the shaft until the line of sight falls on the aiming point. Tighten the thumbscrew.

*k. Levels.*—(1) Traverse the director until one of the levels is parallel to a line connecting two of the leveling screws. Adjust the two leveling screws to center the level bubble and center the bubble in the other level by means of the third screw, recentering each level for any displacement caused by centering the other. Traverse the director and note the position of the bubbles each 90° of traverse. If the bubbles move off the center more than one division of the scale on the vial, repeat the leveling operation until minimum bubble movement is obtained. If the minimum bubble movement exceeds one division on the scale, the levels are out of adjustment and must be corrected by the following method.

(2) At each 90° of rotation, correct one-half of the error in leveling by means of the adjusting nuts in the level box, and the other half by means of the leveling screws. Repeat the complete operation until the bubbles remain centered for any position of the director in azimuth.

**103. Director care and preservation.**—*a. Cleaning external surfaces.*—(1) Remove dust from the metal surfaces of the director with a soft, dry cloth.

(2) Wipe metal surfaces dry with a soft, dry cloth as soon as possible after being exposed to rain or water.

(3) Remove dust from the windows by brushing lightly with a camel's-hair brush or lens tissue. The use of a cleaning cloth is prohibited.

(4) Remove grease from the windows by applying alcohol sparingly with a camel's-hair brush and wiping dry with paper, lens, tissue.

(5) No attempt should be made to clean the windows by wiping with the finger.

(6) Remove the rubber eyeshields occasionally and wash in warm water.

*b. Cleaning optical parts.*—(1) Special care must be exercised to keep the exposed optical elements of the telescopes clean and dry. Dust and moisture will etch and discolor the surfaces if permitted to remain on them.

(2) Remove dust from the lenses by brushing lightly with a camel's-hair brush. The use of a cleaning cloth is prohibited.

(3) Remove grease or oil by applying alcohol sparingly with a camel's-hair brush and wiping dry with paper, lens, tissue. If alcohol is not available, breathe heavily on the lens and wipe dry as directed above. Repeat the procedure until the lens is clean.

(4) Do not wipe the lenses with the fingers.

(5) The use of cleaning fluids or pastes is prohibited.

*c. Internal cleaning.*—Cleaning of the internal mechanisms should be done only by authorized personnel. See paragraph 113.

*d. Lubrication.*—(1) Lubrication of the mechanisms of the director by operating personnel is not permitted. The director will be cleaned and lubricated periodically by authorized personnel.

(2) Apply a few drops of oil to the handwheel knob pins to keep the knobs working freely.

(3) Apply oil occasionally to the leveling screws in the tripod head to insure smooth and easy movement of the screws.

(4) Maintain a light coat of oil, lubricating, for aircraft instruments and machine guns on all unfinished surfaces and parts from which paint has been removed to prevent rust.

(5) Use only oil, lubricating, for aircraft instruments and machine guns for the above purposes.

**104. Changing director range scales.**—*a.* Six range scales are issued with each director. Five of these range scales are for use with

the 37-mm antiaircraft gun M1A2 firing HE Shell M54 and PD fuze M56. Some of these range scales might be labeled for HE Shell M54A1.

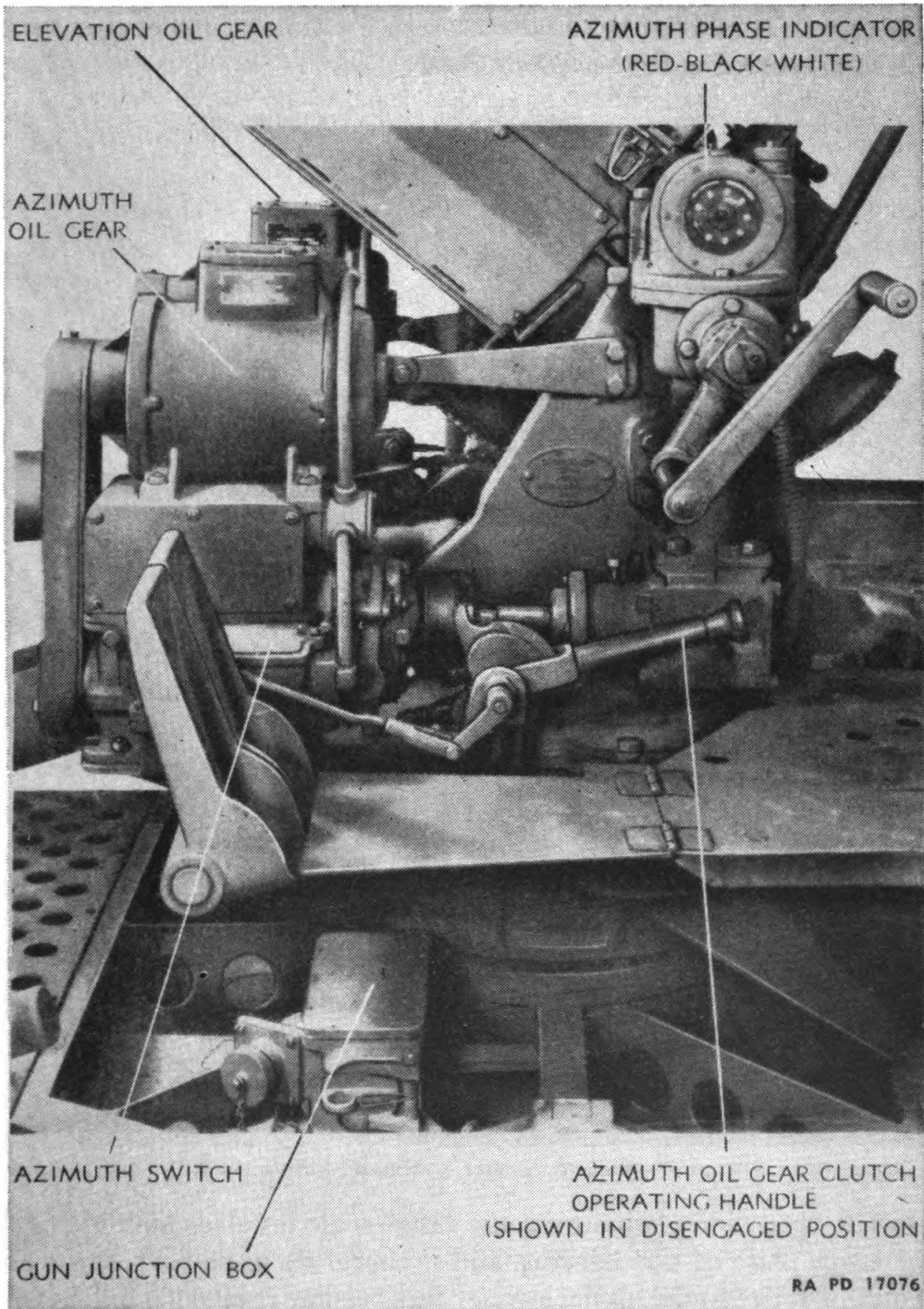


FIGURE 96.—Remote-control system M1—azimuth side.

However, such scales should be used for the HE shell M54. (The sixth scale is for use with 40-mm antiaircraft gun matériel.) The five scales

for 37-mm antiaircraft gun are graduated for muzzle velocities of 2400, 2450, 2500, 2550, and 2600 feet per second, and are identified by the corresponding legend engraved on each scale. The 2600-feet-per-second scale is assembled in the director at the time of issue. The extra scales are carried in the accessory chest.

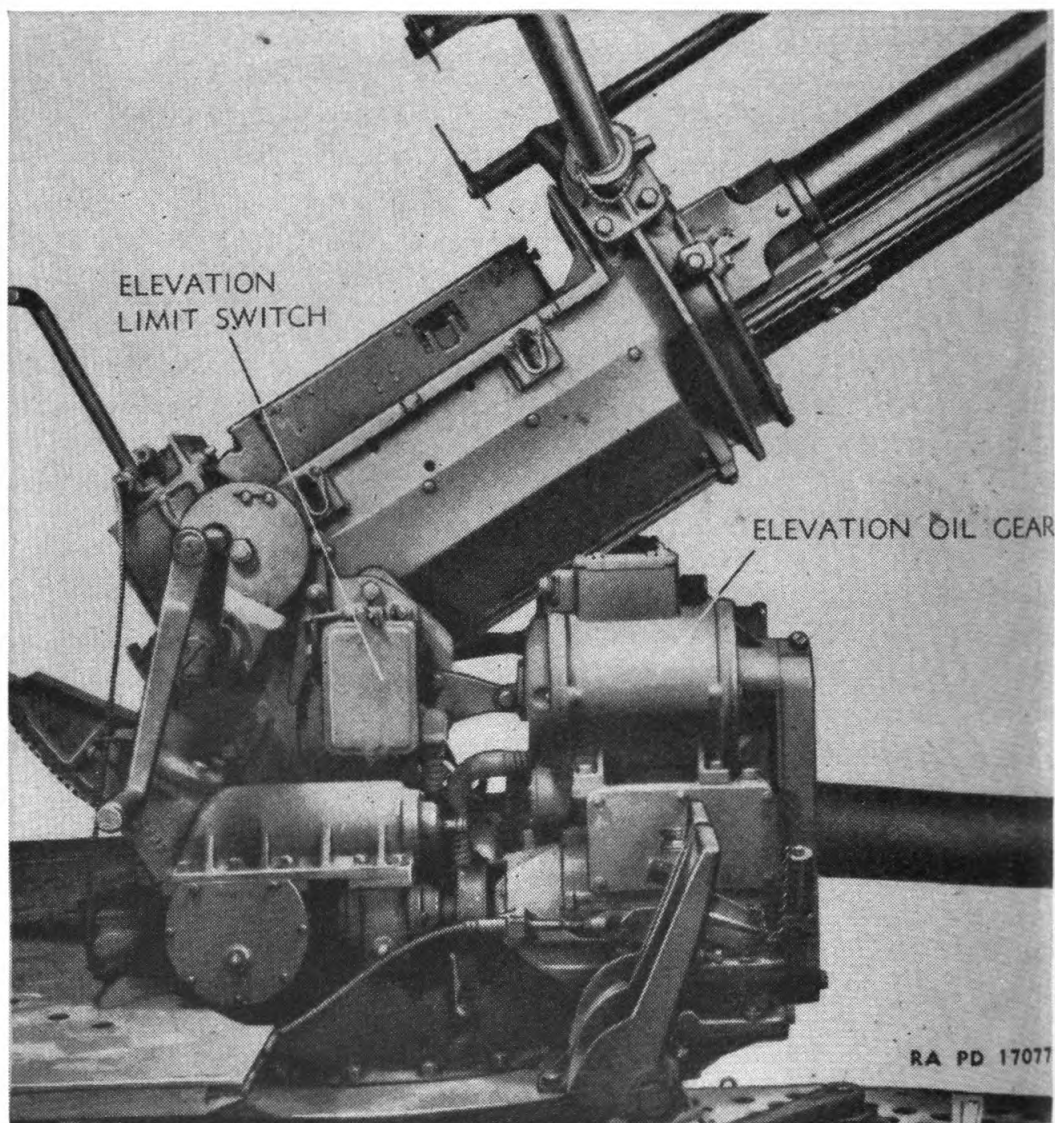


FIGURE 97.—Remote control system M1—elevation side.

b. The operation of changing the range scale involves removal of the rear cover plate of the director, and is therefore to be performed only by qualified personnel, under proper supervision (par. 113). The work should be performed in a dry, closed room free from floating dust, and extreme care must be taken to prevent any dirt or foreign matter from entering the interior of the director.



c. To change the range scale, proceed as follows:

(1) Remove 22 fillister-head screws at the edges of the rear cover plate. Start removing the screws from the bottom. While removing the last few screws at the top, support the cover plate by means of the two small knobs thereon. When all the screws have been removed, lift the cover plate up to clear the range handwheel and remove the cover plate from the director.

(2) Remove the three screws which secure the range scale to the supporting bracket and remove the range scale.

(3) Put the new range scale in place and refasten by means of the three screws.

(4) Replace the rear cover plate, sealing all contacting surfaces with grease, special, low temperature, and tightening all screws securely.

d. It will be noticed that a superelevation (SE) setting is specified on the range scale. However, adjustment for this setting entails removal of the front cover plate of the director and is not normally done in the field. An average value of this setting is used, and corrections for other muzzle velocities are applied during operation by setting a suitable range.

**105. System, remote control, M1.—a. General.**—(1) The remote control system M1 is an electrically-controlled hydraulic power system designed for use with the 37-mm antiaircraft gun carriage M3A1. It is controlled by the antiaircraft director M5 (par. 100) with power supplied from the generating unit M5 (par. 108). The function of the remote-control system as a whole is to point the gun accurately in azimuth and elevation according to the output data supplied from the antiaircraft director. This type of control is known as "remote gun control."

(2) Two oil gear units, one for azimuth and one for elevation, supply controlled driving power for traversing and elevating the gun. The gun must be brought into approximate alinement with the director before the oil gear may be engaged, but once the oil gear is engaged the gun will follow the director accurately. Approximate alinement of the gun with the director is shown by an azimuth phase indicator (with "red-black-white" dial) (fig. 102) mounted on top of the azimuth gear box.

(3) The system permits continuous tracking in azimuth, but is limited in elevation by an elevation limit switch which automatically goes to "off" before the mechanical limit stops are reached.

**b. Description.**—(1) The arrangement of the principal on-carriage parts of the remote control system are shown in figure 98. Cable connections from the director and generating unit are made to the

gun junction box (fig. 99) on the carriage chassis. The cable from the director is 60 feet long, and the cable from the generating unit

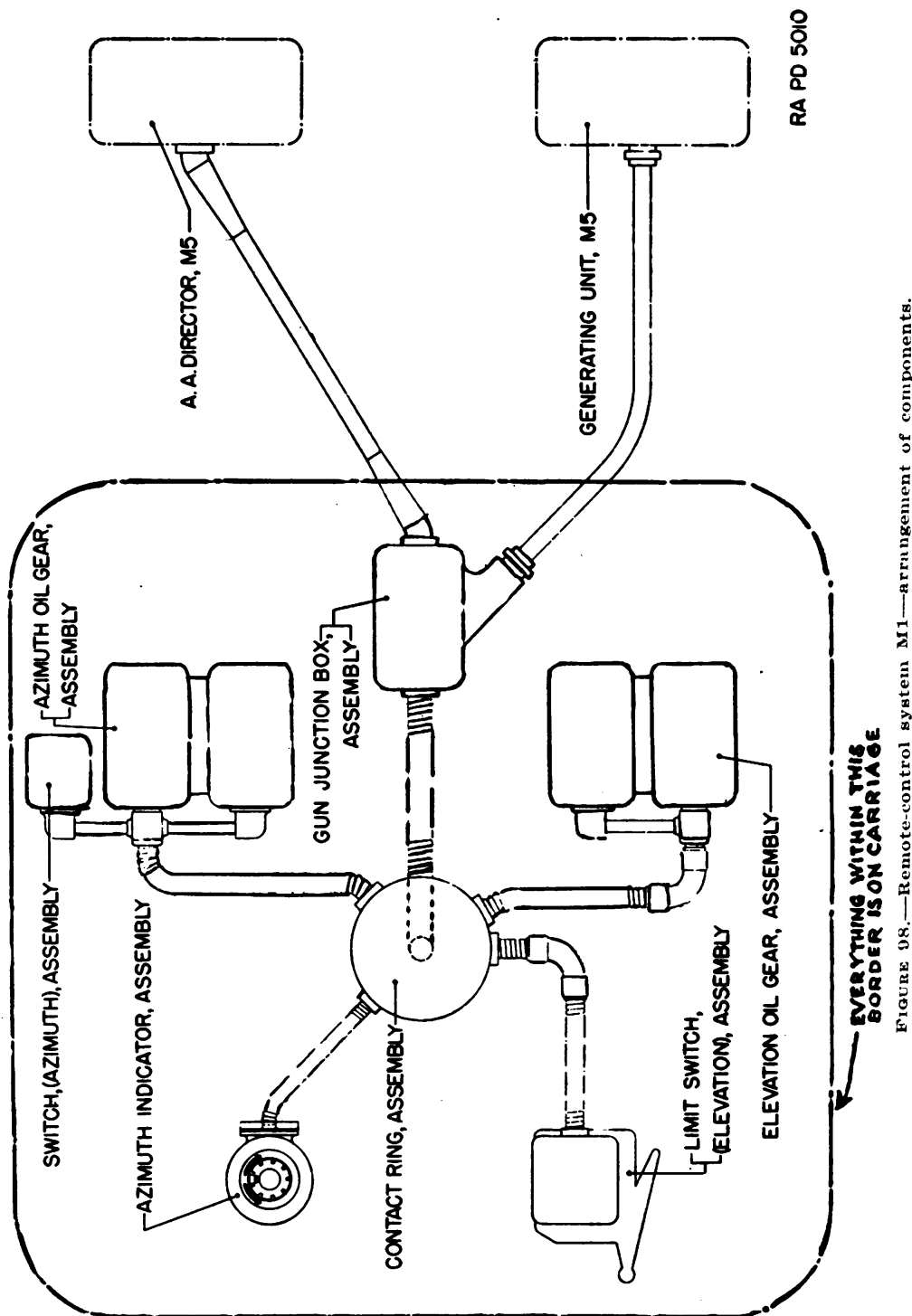


FIGURE 98.—Remote-control system M1—arrangement of components.

is 225 feet long. Electrical connections pass to the top carriage through the contact ring, which permits traversing the gun without kinking or twisting the external connecting cables.

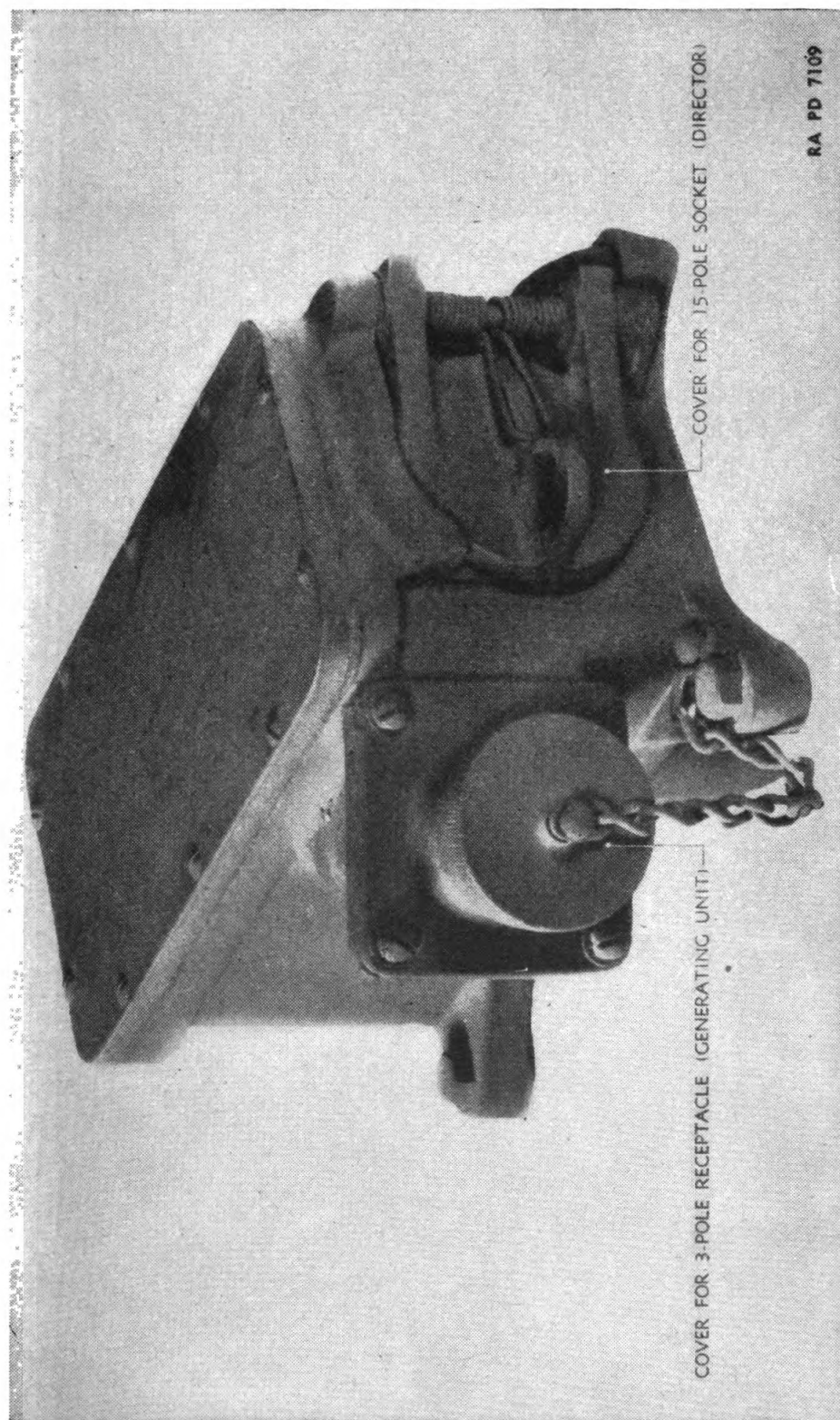


FIGURE 99.—Gun junction box.

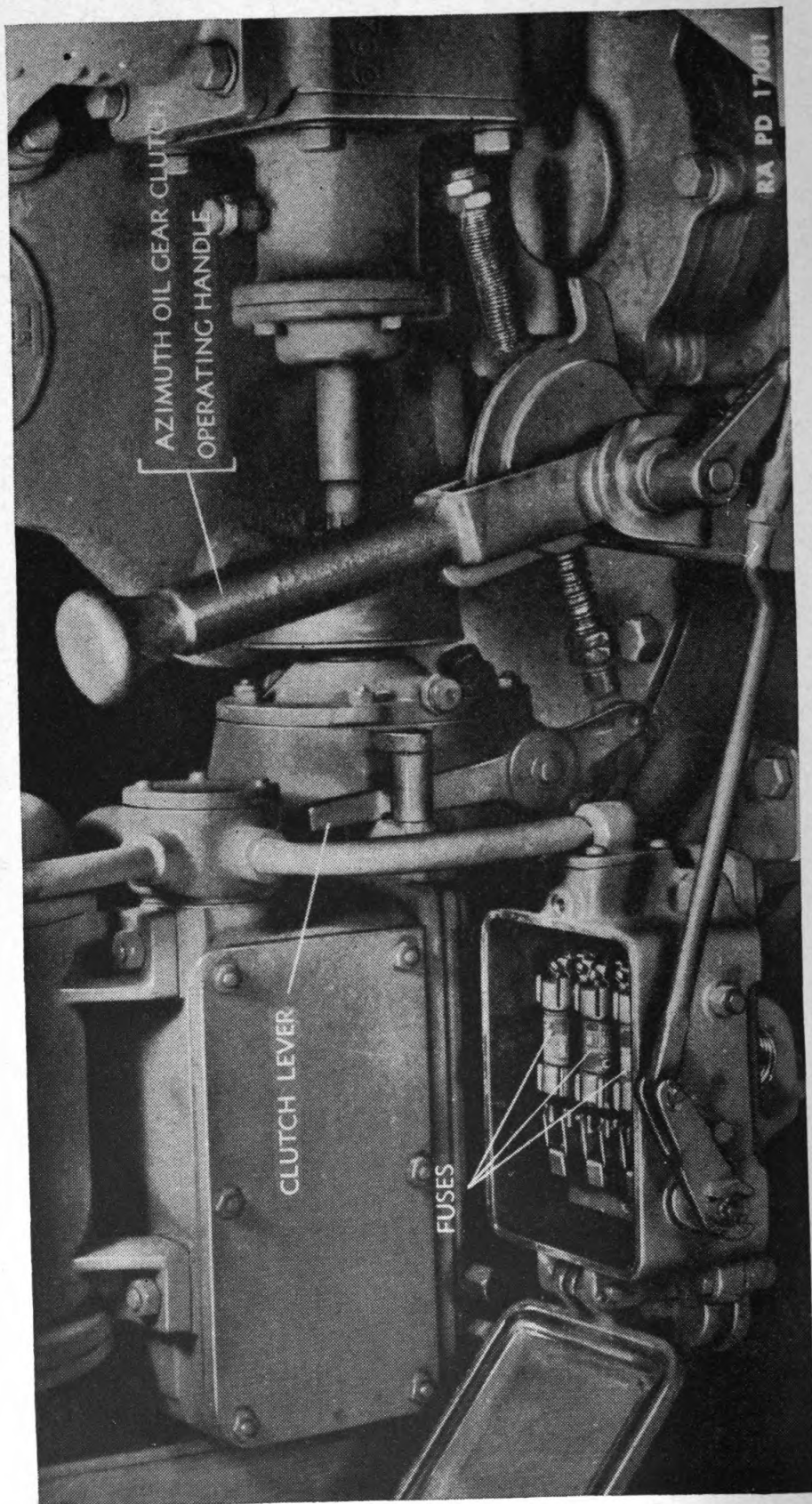


FIGURE 100.—Azimuth oil gear clutch operating handle.



(2) Two oil gear units are mounted on the top carriage. The elevation oil gear is on the right front portion, and the azimuth oil gear on the left front portion of the top carriage. Each oil gear (fig. 103) is a weather-tight assembly consisting of an electric motor at the top, then an electrical control unit, and at the bottom, an oil pump and oil motor in a single housing. The electric motor drives the oil pump through a chain drive enclosed in an oil-tight housing. The electrical control unit operates a sensitive valve which controls the flow of oil to the oil motor. The lower rear portion of each oil

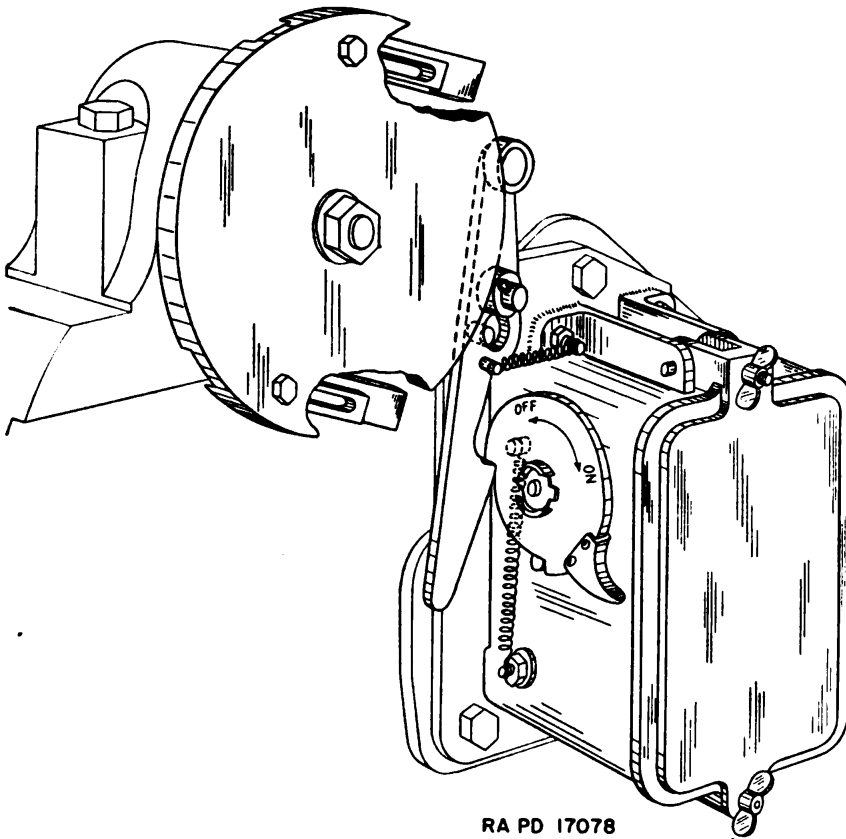


FIGURE 101.—Elevation limit switch.

gear houses a clutch mechanism for disengaging or engaging the oil gear to the gun maneuvering mechanism. The clutch is engaged when the top of the clutch lever is in the forward position.

(3) The clutch lever and power switch (azimuth switch) of the *azimuth* oil gear are both connected to the clutch operating handle of the gun carriage; the clutch is engaged and the switch is on when the operating handle is in the forward position. The clutch lever and power switch (elevation limit switch) of the *elevation* oil gear operate independently of each other. The elevation oil gear clutch lever is operated directly by hand and has an auxiliary lever located

behind the clutch lever which locks the clutch lever in either "in" or "out" position. The clutch is disengaged when the top of the lever points towards the coupling and engaged when the top of the lever points away from the coupling. The power switch (elevation limit switch) is mounted on the gun trunnion and is arranged to trip automatically at the upper and lower elevation limits. (See fig. 101.)

(4) The azimuth phase indicator (fig. 102) is used as an alinement indicator when synchronizing the gun with the director, after slewing the gun carriage. It consists of a circular black shutter operated by

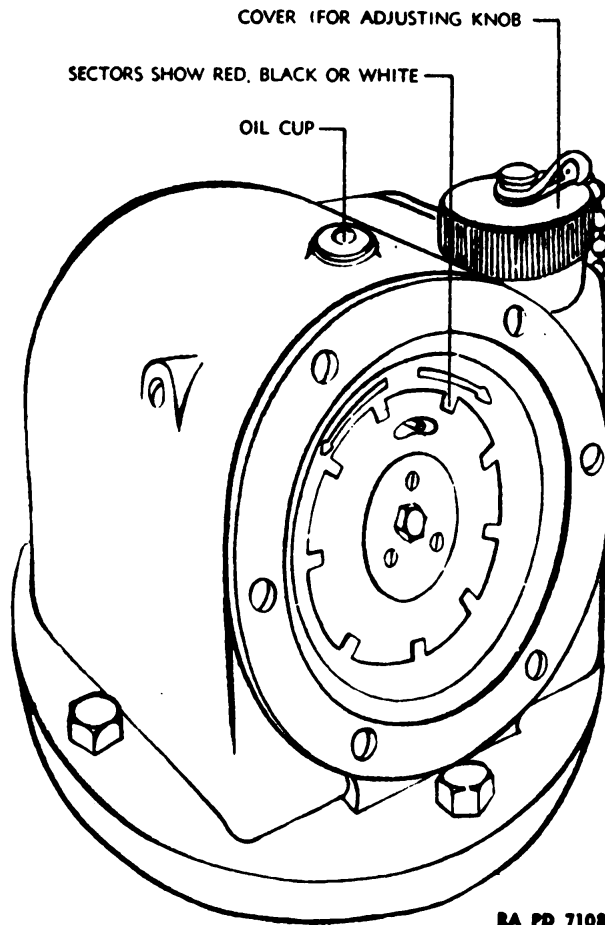


FIGURE 102.—Azimuth phase indicator (red-black-white indicator).

a synchronous repeater and a mechanical dial with red, black, and white sectors. The synchronous repeater follows the rotation of the coarse azimuth transmitter in the director, and the dial is geared to the traversing mechanism of the gun carriage. An index pin on the mechanical dial, protruding through a slot in the shutter, holds the shutter in the red or white phase if the gun is not lined up with the director within the same 20° segment of azimuth. If the gun is

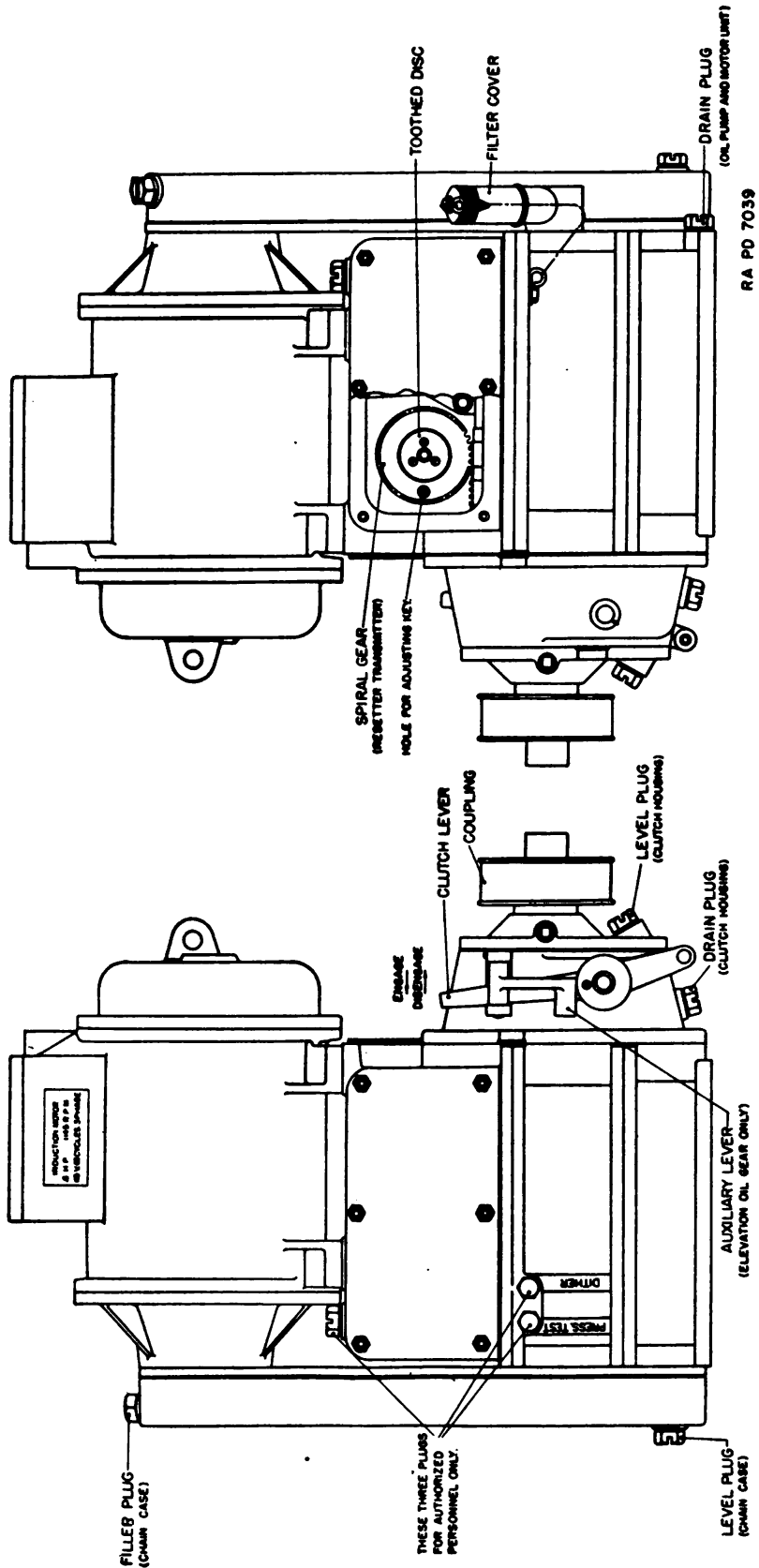


FIGURE 103.—Oil gear (portion of cover cut away to show adjustment of resetter transmitter).

alined with the director, the surface will become black; if not, either red or white will show. A narrow strip of red or white indicates approximate alinement.

**106. Remote control system operation.—a. Initial set-up.—**

(1) Before firing operations are started the gun carriage must be leveled accurately and lined up with the director (*b* below). Instructions for lining up at the director are contained in paragraph 101. Instructions for leveling are contained in paragraph 30.

(2) Since there are no provisions for parallax corrections, and since in the prescribed method of fire adjustment it is necessary for the trackers to see tracers that cross the gun-target line, the director should be emplaced at one gun barrel's length from the mount. This results in a dead sector which extends about  $35^\circ$  to either side of the director in which the gun should not be fired due to hazard to the director personnel.

(3) Connect the generating unit and director to the gun mount by the cables provided, making sure that all switches are open until cable connections have been completed. The "D" plugs of the director cable have an adapter ring which must be turned to lock the plug in its socket. The plugs of the generating unit cable have a round nut which must be screwed to the body of the mating receptacle.

(4) The main power switch is on the control panel of the generating unit. This switch should not be thrown until the cables have been connected and the cable plugs secured.

*b. Lining up gun and director.*—When the preliminary operations at the director (par. 101) have been completed, and the director telescopes have been set to the same elevation as the gun (par. 101*d*), the following procedure will be taken:

(1) Start the generating unit (par. 109) and then close the main switch on the control panel to apply power.

(2) *Be sure that the azimuth and elevation hand cranks are disengaged. Keep personnel clear of mount.* Slew the gun (azimuth oil gear clutch operating handle to the rear) until the gun points approximately in the same direction as the director telescopes, and then push the operating handle forward, energizing the remote-control system.

(3) Engage the elevation clutch and close the elevation limit switch.

(4) Boresight the gun on the aiming point (reference point) by means of the director (par. 101*e*).

(5) When the gun is accurately on the aiming point, the azimuth telescope on the director should be checked to see if the vertical cross line of the telescope is on the point. If it is, the gun and director



are alined in azimuth; if not, the director will have to be traversed independently of the gun to bring the vertical cross line accurately on the point.

(6) The boresighting should be checked on a second aiming point or on the same aiming point after the director and gun have been traversed through a large arc.

(7) After the gun and director have been accurately alined, the mechanical dial of the azimuth phase indicator must be adjusted, if the indicator shows either red or white. This can be done by removing the cover over the adjusting knob (fig. 102), depressing the knob, and turning it to rotate the dial. Rotate the dial so that the pin projecting through the shutter is in the center of the slot and the indicator face is completely black. When the knob is turned clockwise, the pin will rotate clockwise and vice versa.

(8) The gun can be checked for elevation by means of a gunner's quadrant. With the system energized, check the gun elevation against the reading of the elevation dial at the director. The check should be performed at two points, preferably  $0^\circ$  and  $30^\circ$ .

(9) After all the necessary adjustments have been made, both the gun and the director should be set at an elevation of  $30^\circ$  (or any other selected elevation, provided the same setting is used at both the gun and director) so that the gun will line up with the director as soon as the system is energized.

*c. Tracking the target.*—(1) When the target is sighted, the elevation limit switch on the gun carriage should be closed by pressing the switch down (fig. 101) so as to energize the elevation oil gear. The elevation oil gear clutch should always be engaged before the elevation switch is closed.

(2) Close the main switch on the generating unit to energize the system.

(3) When the director picks up the target, bring the gun into line with the director by traversing the gun until the azimuth indicator shows black, and then push the operating handle forward. This last operation throws the azimuth switch and engages the clutch in the azimuth oil gear. It is not necessary for the azimuth phase indicator to be completely black when throwing the azimuth switch, as the gun will synchronize with the director if initially alined within  $10^\circ$ , that is, if a narrow strip of red or white shows through the shutter.

(4) After the director picks up and tracks the target, it computes the firing azimuth and quadrant elevation and transmits these electrically to the oil gears which operate the gun. All human pointing errors at the gun are eliminated by the remote control system. Once the

target is picked up and a rate set in, no corrections can be made at the gun.

(5) The gun can be traversed through 360° but no firing should be done when traversing through the dead sector (par. 106a(2)) due to the hazard to director personnel. The gun battery should be located so that the dead sector of each gun is covered by another gun.

(6) Whenever the gun has engaged one of the elevation limit stops and tripped the elevation limit switch, the gun will have to be elevated or depressed manually to bring it inside the limiting angle, and then realigned with the director. As soon as this has been done, the hand crank should be disengaged and the switch reset.

*d. Changing targets.*—(1) When the order is given to track a new target, pull back the operating handle and slew the gun to aline with the director again. When the azimuth phase indicator shows black, indicating alinement with the director, push the operating handle forward, energizing the oil gear.

(2) The elevation clutch and switch should remain engaged as there is no provision for slewing the gun in elevation.

*e. Cease tracking.*—Both the gun and director should be set at an elevation of 30° (or any other selected elevation, provided the same setting is used at both the gun and director) so that a new target can be picked up without delay.

*f. Faults.*—If the gun does not follow the director both in azimuth and elevation when tracking a target, the errors made are caused either by the mistakes of the operators at the director and the gun or by some mechanical or electrical imperfection in the remote-control system or the director. Faults at the gun may be:

(1) Bad lining-up. The breech peep sight and muzzle crosswires should be used if they are available.

(2) Top carriage out of level. The correct leveling of the gun and top carriage cannot be overstressed. Any error in leveling will cause a corresponding error in elevation.

(3) Engaging the oil gear before the gun is approximately in line with the director.

(4) Forgetting to reset the elevation limit switch after it has been automatically thrown to "off."

**107. Remote control system care and preservation.**—*a. Routine maintenance.*—The operations described below can be performed by the using troops under supervision of competent personnel. Any further maintenance operations, such as disassembly of oil gears or azimuth indicator, should be done only by ordnance maintenance personnel (par. 113). Periodic examination of the various units should

be made to insure that the system will not become inoperative due to the need of some minor adjustment or repair that could have been readily performed prior to the time of operation.

(1) If the induction motor in either oil gear does not run when power is applied, the trouble may be due to blown fuses in the elevation limit switch or azimuth switch. There are three fuses in each switch box. The fuses are accessible for replacement on removal of the switch box cover. Fuses are rated 15 amp., 250 volt ("Eco" fuse, No. 1115 type). Remove power from the system before attempting to replace fuses. Secure switch box cover tightly after fuse replacement.

(2) If the gun follows erratically, indicating low oil level, remedy by replenishing the oil supply. Fill the unit through the oil filter, using new cans of approved oil. Use only oil, hydraulic. Fill until oil flows out through the small pilot hole in the filter body. Screw filter cover on tightly after filling.

(3) If the system still fails to operate properly, the cause may be either a fault in the electrical connections, or a malfunction of the mechanical parts of the oil gear. However, no changes in the electrical circuits may be made by the using troops, and if the operating symptoms indicate any reversed leads or mechanical failure, the repairs must be made by qualified personnel (par. 113). The using troops are permitted to perform unit replacement of oil gears in case of failure of a unit, but proper facilities must be available to prevent entrance of dust into the interior when cover plates are removed.

*b. Replacement of oil gear units.*—(1) Disconnect the three leads to the electric motor by removing the terminal well cover plate on the top of the motor and loosening the three terminal screws. Note the lead markings (mark the leads if there are no lead markings) to insure that the leads can be reconnected to their corresponding terminals. Remove the four screws securing the conduit elbow to the motor housing and withdraw the wires from the terminal well.

(2) Remove the left cover plate of the transmitter and electrical differential assembly, exposing the terminal screws. This cover is on the same side as the clutch lever. Disconnect three leads (R1, R2, R3) to the differential and two leads (X, Y) to the resetter transmitter by loosening the terminal screws. Do not disconnect the interconnecting leads (S1, S2, S3, and 1, 2, 3). Note the lead markings (mark the leads if there are no lead markings) to insure that the leads can be reconnected to their corresponding terminals. Remove the three screws securing the conduit box to the housing and withdraw the wires from the housing.

(3) Remove the four bolts securing the oil gear to the carriage, and the single bolt at the rear of the electric motor. Remove the oil gear by pulling it forward from the front of the carriage, being careful not to damage the drive shaft or coupling mechanism.

(4) Note that in replacing a unit, a distinction must be made between the azimuth oil gear and the elevation oil gear. Although both units are similar in outward appearance, they cannot be interchanged as their gearing ratios are different. The azimuth unit has a 64-tooth spiral gear (A182178) on the resetter transmitter, while the elevation unit has a 108-tooth spiral gear (A182177). Also, a different pinion meshes with these gears in each unit. In the absence of accurate name plate data, the unit can be positively identified by removing the adjusting side cover (this cover is on the same side as the filter cap) and counting the teeth on the resetter transmitter spiral gear.

(5) Mount the replacement oil gear on the carriage, pass the cable leads into the corresponding openings, and secure the conduit fittings. Be sure to insert the gaskets under the cable adapters. Connect the leads to the correspondingly marked terminals, and tighten the terminal screws securely. Replace cover plates with their gaskets. Use new gaskets if necessary.

(6) When replacing the elevation oil gear, it will be necessary to adjust the resetter transmitter. This is done before replacing the adjusting side cover. To adjust (fig. 104), loosen the three screws in the central toothed disk which secures the spiral gear to the resetter transmitter. Energize the system, and set the director telescopes to exactly  $45^\circ$  elevation. By use of the adjusting key (*g* below) turn the toothed disk until the elevation of the gun as checked by the gunner's quadrant is exactly 800 mils ( $45^\circ$ ). Tighten the three screws to retain the adjustment.

(7) It is not necessary to adjust the resetter transmitter of the azimuth oil gear, as the equivalent adjustment is performed during the orienting operation.

*c. Conversion of elevation oil gear to azimuth oil gear or vice versa.*—The specific instructions below supplement instructions contained in the preceding portions of this paragraph.

(1) One spare oil gear assembled as an elevation unit is furnished with every two carriages. A package of spare parts consisting of a spiral gear, a taper pin, and a sleeve, to be used in converting the elevation unit to an azimuth unit, is also furnished.

(2) In order to convert an elevation oil gear to an azimuth unit, the right-hand side cover plate must be removed, the three screws clamp-



ing the spiral gear between the disk and adapter on the gear assembly (fig. 107), must be withdrawn and the disk and gear removed.

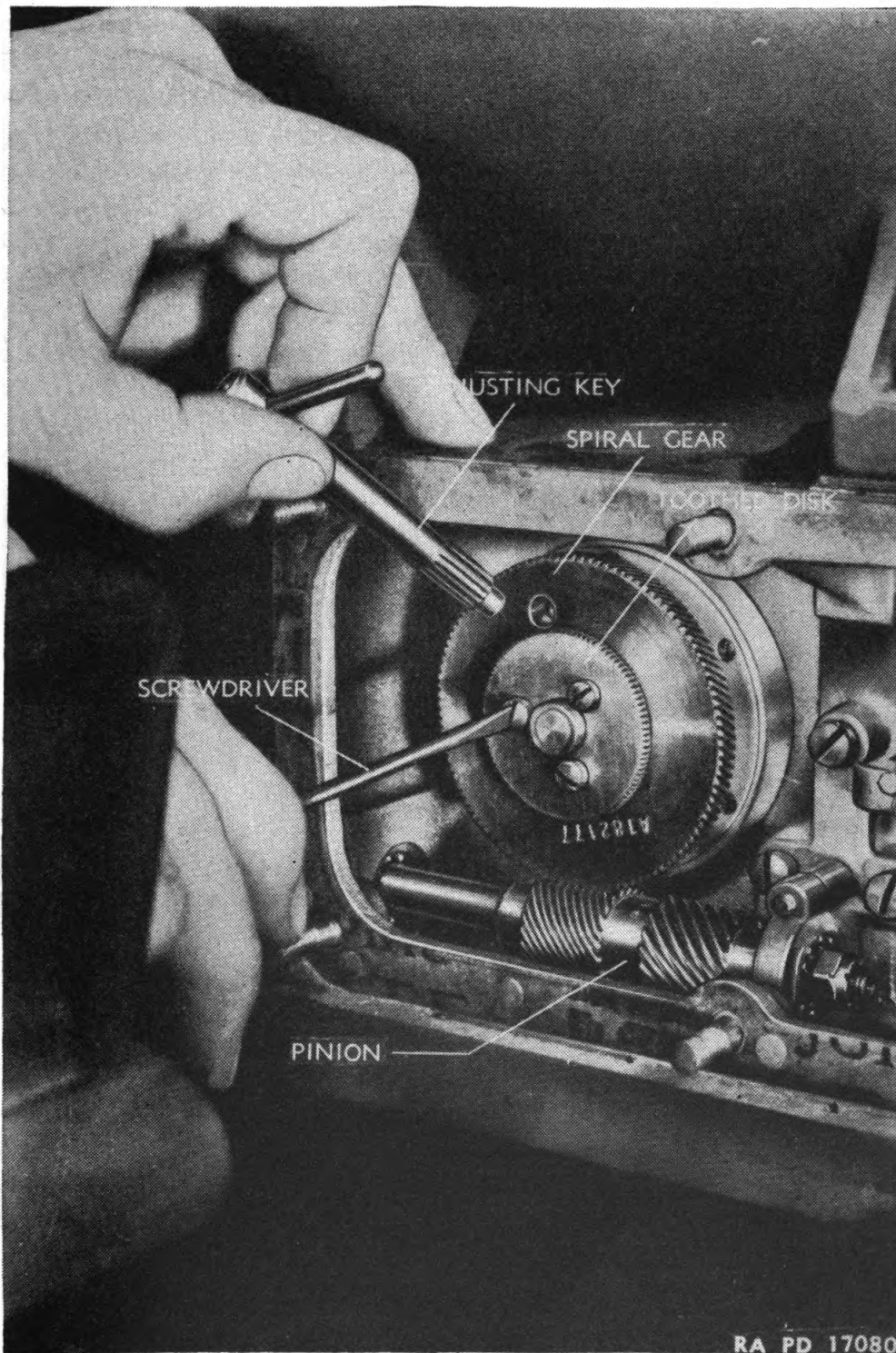


FIGURE 104.—Adjustment of resetter transmitter spiral gear.

(3) The taper pin securing the double pinion on the shaft assembly must be driven out, the pinion slid over to the left side of the shaft and secured by replacing the cotter pin. If the pin is damaged, use the spare taper pin supplied to secure the pinion to the shaft.

(4) Mount the spare spiral gear (azimuth) (A182178), replace the disk and secure the two to the adapter by means of the three screws that were withdrawn, taking care to mesh the gear with the right-hand pinion as shown in figure 107. Replace the gasket and cover plate.

(5) Remove the four nuts holding the rear bell housing of the induction motor to the motor housing. Rotate the bell housing 180 degrees and secure in place in the new position.

(6) Interchange the pipe plug and grease fitting in the clutch housing cover and secure in place.

(7) Remove the cotter pin on the shaft pin which supports the auxiliary locking lever (fig. 103). Drive out the shaft pin and remove the locking lever. Insert the spare sleeve, drive the shaft pin back in place and secure it by means of the cotter pin.

(8) An azimuth unit can be converted to an elevation unit by reversing the above replacements and assemblies.

*d. Care of cables and component parts.*—Give the cables the best of care. See paragraph 111, cable repair kit M3.

(1) No cable of this size will withstand repeated kinking or twisting. Avoid bending the cable on a short radius, or allowing it to chafe against a movable object.

(2) Do not allow vehicles to run over unprotected cables.

(3) Keep plugs and receptacles clean; accumulated dirt will cause faulty connections.

(4) When the cables are not connected, all plugs must be kept closed with the covers provided to exclude dirt and moisture from these units. The "D" plugs of the director cable are furnished with leather covers that should be pulled over the plugs when not connected.

(5) When disconnecting a cable, pull on the body of the plug, never pull on the cable or spring. The "D" plugs have to be turned to unlock them before they can be disconnected.

(6) In case it becomes necessary to tape the ends of any of the flexible cables, use rubber tape only.

(7) Oil and grease are detrimental to rubber; keep the cables free of these solvents. If oil or grease does get on the cable, wipe it off and wash the place with soapy water.

(8) Protect the cable receptacles in the gun junction box by means of the covers provided for that purpose.

*e. Lubrication and renewal of oil.*—(1) Cleanliness is of the utmost importance in handling the oil for the oil gears. Dust or moisture must not be allowed to get into the oil at any time. The oil gun must be kept clean, and should be used only for the specified oil, hydraulic.

(2) If the system is in frequent use, the oil should be changed every six months. To change the oil, drain through the drain plug under the filter assembly, replace drain plug and tighten securely, then fill through the filter (fig. 106) until oil flows from the overflow hole in the side of the filter. Use only oil, hydraulic, as the hydraulic medium. If dirt is suspected in the oil system, the oil gear unit should be removed and cleaned thoroughly by ordnance maintenance personnel.

(3) The filter contains a filter bobbin assembly which may require replacement after several oil changes. The filter bobbin assembly con-

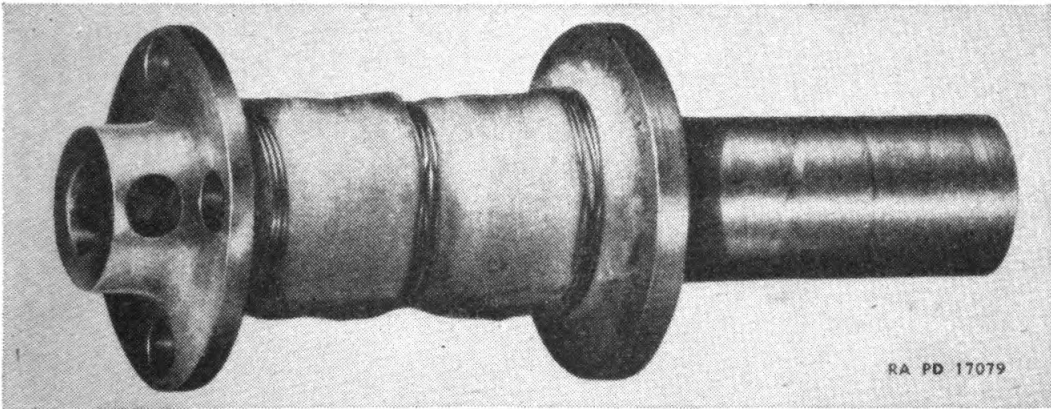


FIGURE 105.—Filter bobbin assembly for oil gear filter.

sists of a perforated metal tube with a muslin strip wrapped around the perforated portion so as to form the filter element (fig. 105). To replace the filter bobbin assembly proceed as follows: Unscrew the retainer at the top of the filter opening, using the spanner provided (*g* below). Lift out the old filter bobbin assembly and replace with a new one. Screw the retainer back into place. Care must be taken during the foregoing operations to prevent dirt entering the interior parts.

(4) At regular intervals, depending on service conditions, fill the chain case and the clutch housing (fig. 103) with oil, hydraulic, to the level of the level plug holes. The chain requires lubrication with grease at six-month intervals, but since this calls for partial disassembly it should be performed only by qualified personnel.

(5) The resetter transmitter spiral gear (fig. 107) is lubricated by a cork lubricating ball located in a recess under the driving pinion.



This recess should be filled with oil, hydraulic, at frequent intervals. The cover over the spiral gear must be removed to permit lubrication.

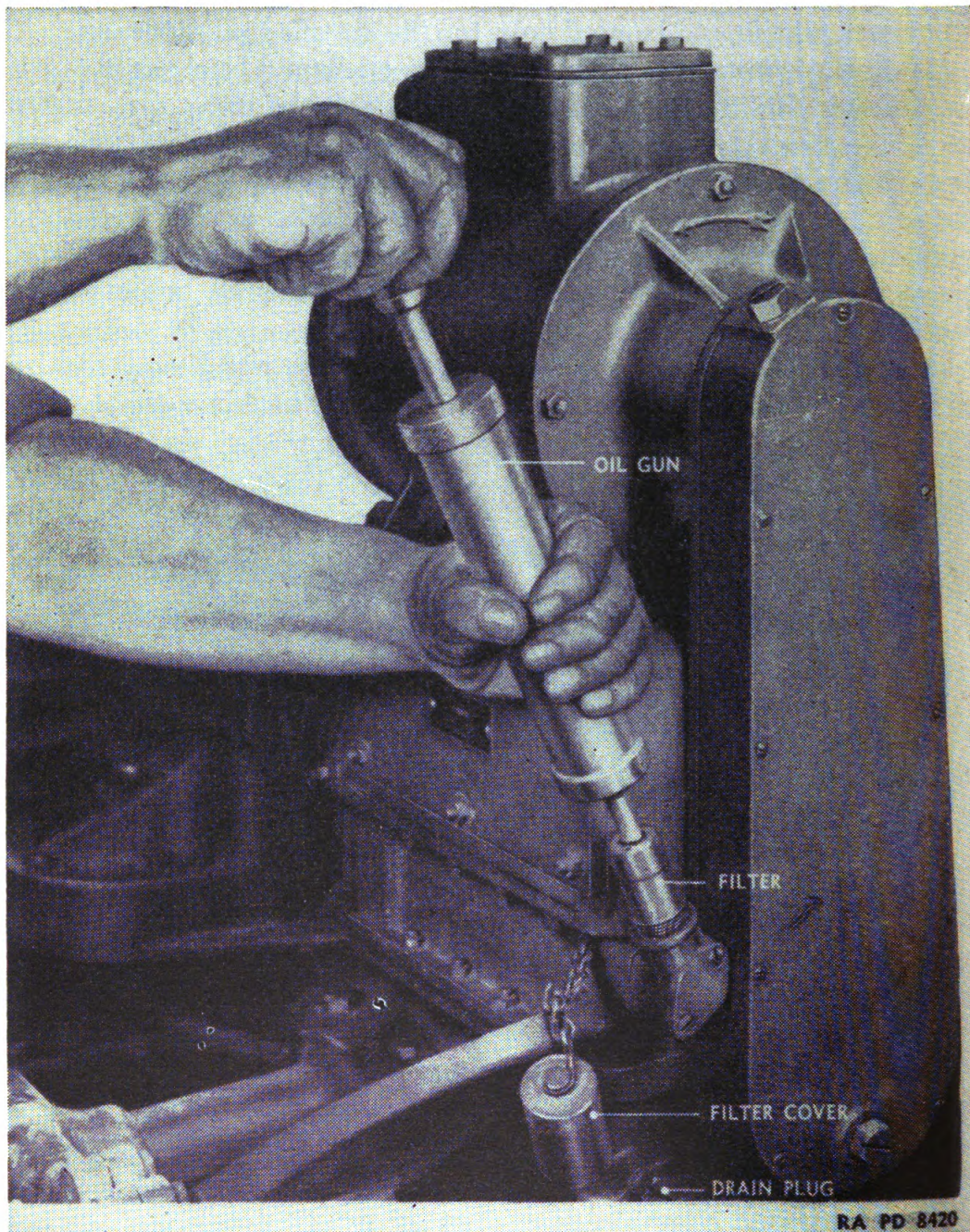


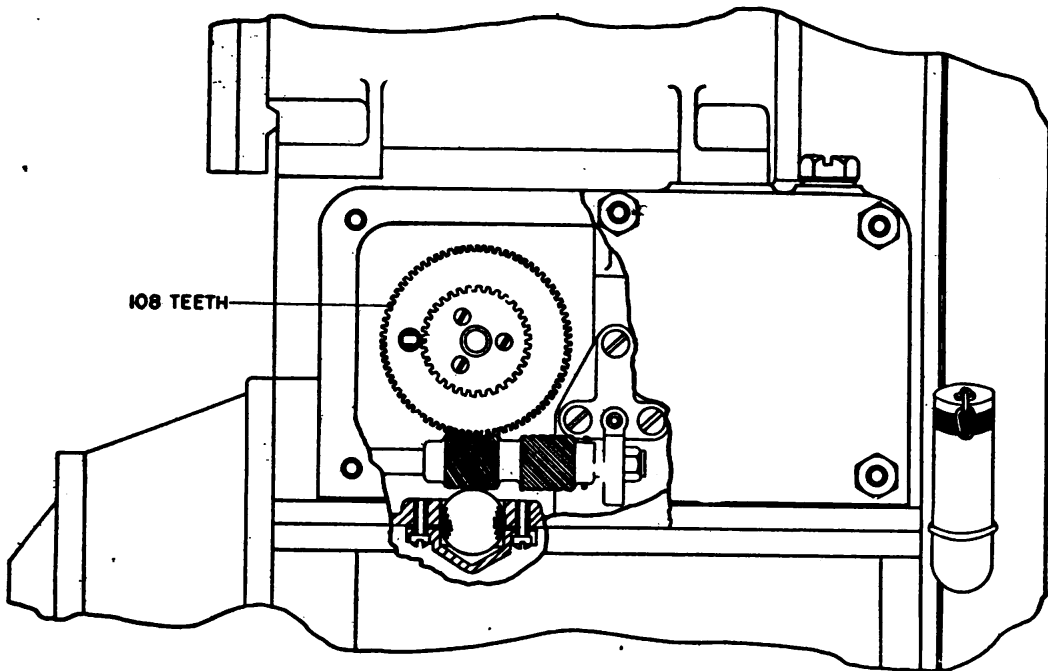
FIGURE 106.—Use of oil gun in filling oil gear.

*f. Precautions.*—The following precautions should be taken in the operation and maintenance of the system:

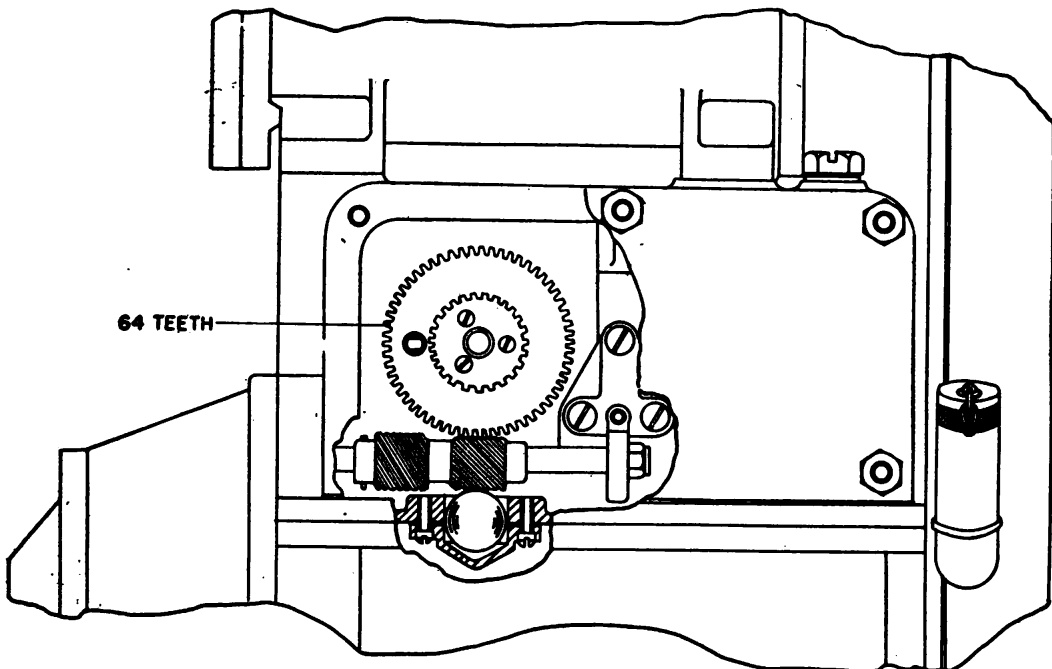
- (1) Power should be switched off before cables are connected or disconnected. See that cables are securely held in the receptacles fore turning the power on.



(2) The elevation clutch lever should be put in the "in" position (top of lever away from the coupling) before switching on the power supply.



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FIGURE 107.—Changes in gearing for conversion of elevation oil gear to azimuth oil gear.



(3) Never put oil from a previously unsealed container in the oil gears.

(4) Be sure the top carriage is level before firing. Only when the carriage is level will the gun accurately follow the director.

(5) The oil gear when filled with oil must always be kept upright, otherwise oil will get into the electrical control elements and cause damage. If, through accident, the oil does get into the electrical control compartment, remove the side covers from this compartment and wipe up any loose oil.

*g. Tools and equipment.*—A tool box containing tools and equipment for maintenance of the oil gear is furnished with the system. Certain of these tools are required specifically for ordnance maintenance operations, and are not intended for use by battery personnel. No screw driver is provided as there is usually a screw driver in the gun carriage tool box. The tools supplied are listed below. When not in use, these tools should always be kept in the box provided.

Coupling gage (for assembling oil gear to carriage).

Oil gun (for adding oil to oil gear unit, fig. 106).

Adjusting key (for adjusting resetter transmitter, fig. 104).

Spanner (for changing filter bobbin assembly).

Ball tongs (for assembling oil pump).

Pulling tool (for removing gears and sprockets).

Tube (for inserting sensitive valve).

12-point box wrench ( $\frac{3}{8}$  and  $\frac{7}{16}$  in.).

12-point box wrench ( $\frac{5}{8}$  and  $\frac{3}{4}$  in.).

**108. Generating unit M5.**—The generating unit M5 (figs. 108 and 109) is a 3-phase a-c gasoline electric unit rated at 3.0 kva, 125 volts, 60 cycles. It is mounted on skids and is furnished with four porter bars so that it can be moved in the field without difficulty. Its overall weight is approximately 800 pounds.

*a. Gasoline engine.*—(1) The engine is a standard commercial four-cylinder, four-cycle, L-head, water-cooled machine which uses standard gasoline as fuel.

(2) The engine is equipped with a cooling system consisting of a water pump, radiator, and fan. The water capacity of the cooling system is approximately five quarts.

(3) The oiling system is the forced feed type. The oil pump delivers oil under pressure to all main bearings and connecting rod bearings. The cylinder bores, tappets, and valve stems are lubricated by the mist of oil thrown off by the connecting rods and main bearings.

(4) *Rating.*—The rating of the engine is as follows:

Bore and stroke, inches-----	25 $\frac{5}{8}$ x 3
Number of cylinders-----	4
N. A. C. C. horsepower-----	11
Piston displacement, cubic inches-----	64.9
Firing order-----	1-2-4-3

*b. A-c generator.*—(1) The generator is a 3-phase, alternating current, revolving field type machine, with a separate built-in exciter. It is designed to give 60 cycles, 125 volts when driven at 1,200 rpm; or 50 cycles, 130 volts when driven at 1,000 rpm. *The generator should always be set for 60 cycles when operating the director M5, and remote control system M1 ((5) below).* The 50-cycle generator setting is used only with certain types of British matériel.

(2) The direct current generator used for the separate excitation is mounted on the same shaft with the revolving field, between the generator bearings.

(3) Power is taken from the unit through the 3-pole receptacle (fig. 108) located at the lower right-hand corner of the housing under the instrument panel.

(4) All operating controls are grouped on the instrument panel (fig. 110). The generator controls located on the lower portion of the panel consist of an ammeter, voltmeter, frequency meter, a voltage control rheostat, a fuse in each of the three-phase lines and a combination main power switch and circuit breaker. A receptacle for attaching an extension cord and lamp for use as a trouble light is located at the bottom of the panel.

(5) The change from 50 to 60 cycles or vice versa can be made if necessary by changing the links on the subpanel as shown in figure 111 and adjusting the governor speed change screw to give the desired speed or frequency. The subpanel is located in the tool box compartment, above the generator. The speed must be set to 1,200 rpm to give 60 cycles. This can be checked by reading the frequency meter.

*c. Electrical system.*—(1) The engine electrical system is of standard automotive type, consisting of a 6-volt, 100 ampere-hour, storage battery, a charging generator, a starting motor, an ignition switch, a coil and a distributor.

(2) The storage battery supplies energy for the starting motor, ignition system, and panel board lights. It is charged by a separate generator driven by a V-belt on the left side of the engine. An ammeter on the control panel shows the amount of charging or discharging current. A cut-out relay is mounted on top of the charging

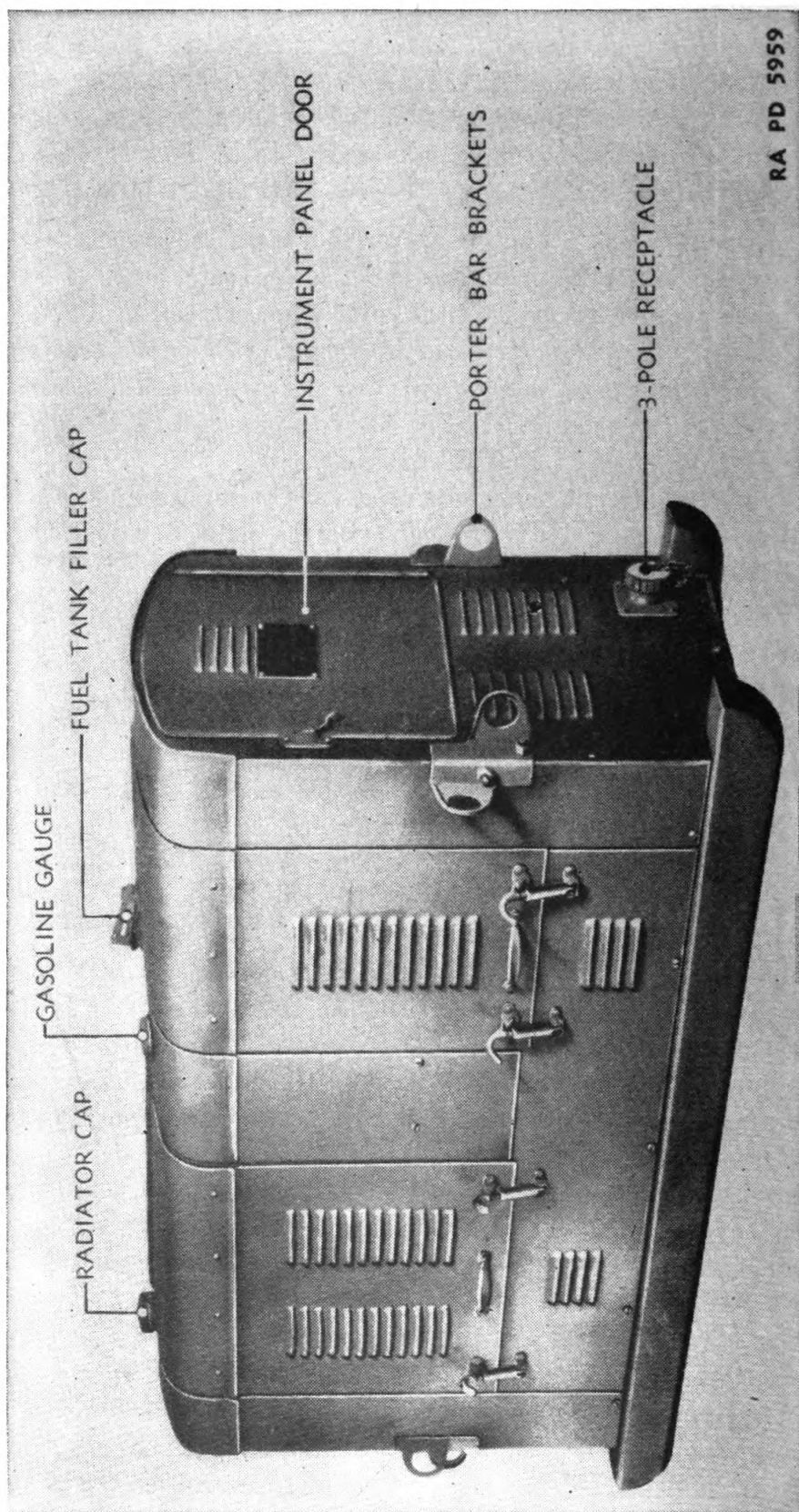


FIGURE 108.—Generating unit M5—rear and left side.



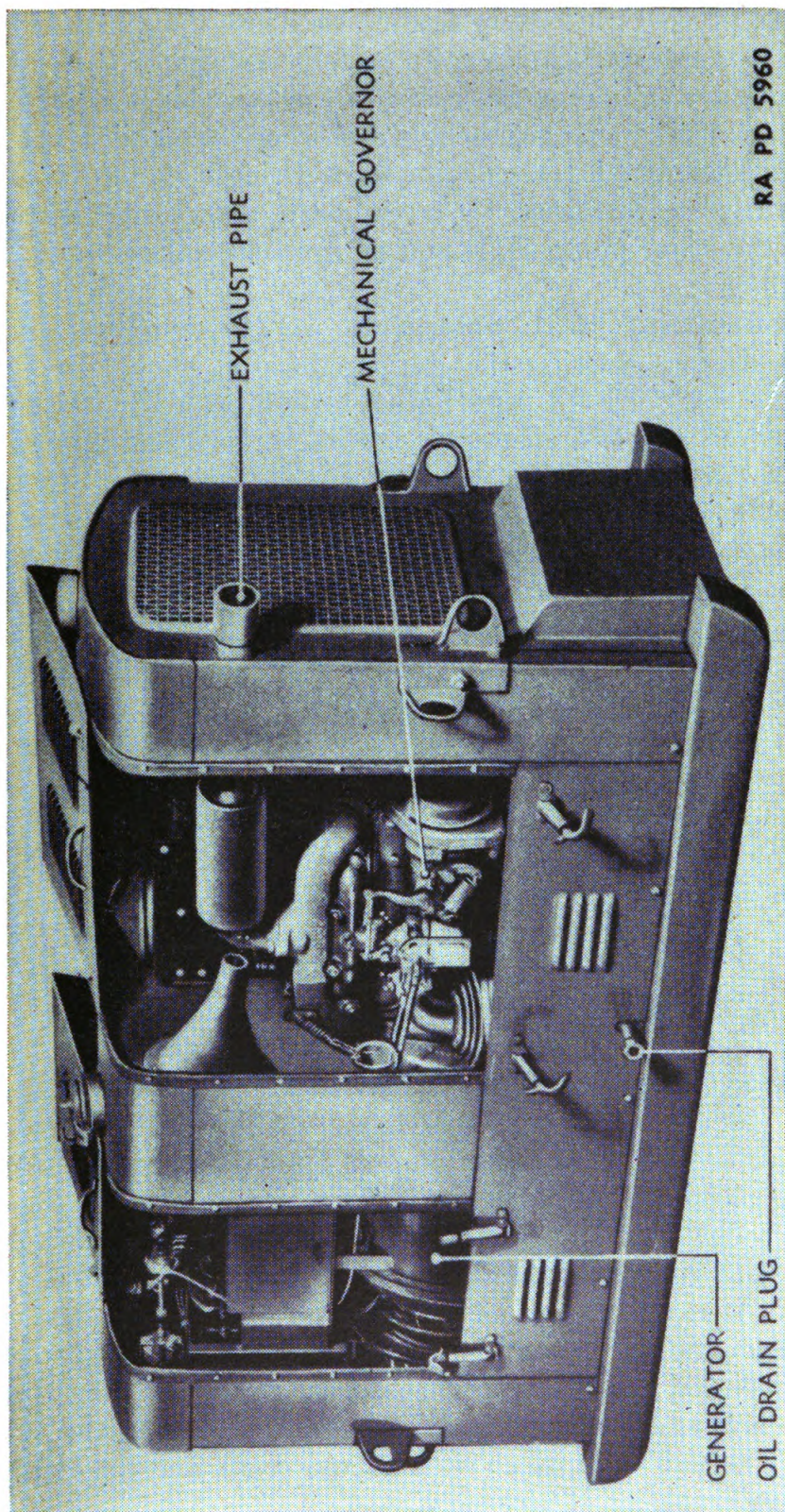


FIGURE 109.—Generating unit M5—front and right side, hood open.



generator to prevent the battery feeding back into the generator whenever generator voltage is lower than battery voltage.

(3) The starting motor is controlled by the starter switch. A pinion automatically engages the flywheel when the motor is energized and then disengages when the engine starts firing.

(4) Ignition is furnished by a standard automotive distributor driven by the water pump shaft and an ignition coil mounted on top of the engine.

**109. Generating unit operation.**—*a. Preparations prior to operation.*—Before starting the engine, the unit should be checked to see that it has sufficient water, gasoline and oil and that the main power switch (fig. 110) is open. Operation for even a short time without either oil or water will be very harmful to the engine.

(1) The normal capacity of the radiator is 5 quarts. The water level can be checked by removing the radiator cap. If the water can be seen above the baffle plate just inside the radiator top tank, there is sufficient water in the radiator. Only clean fresh water should be used; antifreeze should be added when freezing weather is anticipated.

(2) The oil is checked with the bayonet type gage located on the left-hand side of the engine. The oil level should always be kept up to the full mark on this gage. The normal oil capacity is 4 quarts. Use oil, engine, SAE 30 for temperatures above 32° F.; use oil, engine, SAE 10 for temperatures between 32° F. and 0° F. See lubrication chart for lubrication below 0° F.

(3) The capacity of the gasoline tank is 5 gallons. The gage in the top of the tank indicates the amount of gasoline in the tank. The tank is filled through the gasoline safety filler cap to avoid any danger of explosion. A shut-off cock is located under the tank.

*b. Starting the engine.*—Ignition switch, starter button and choke control are located on the instrument panel (fig. 110). To start the engine, turn on the ignition switch and push the starter button, adjusting the choke control as required. If the engine is cold, the choke should be pulled all the way out until the engine starts firing, and then gradually returned to the normal (all in) position as the engine warms up. It is not always necessary to use the choke as the engine may be warm enough to start without any trouble. If the starter is very sluggish and pulls the switchboard light down to very dim, the battery is low and cannot supply enough voltage for the starting ignition. The unit is supplied with a hand crank and the engine can be started by cranking, if necessary.

*c. Application of power.*—After the engine has been started and is operating satisfactorily, the generator is thrown across the line by

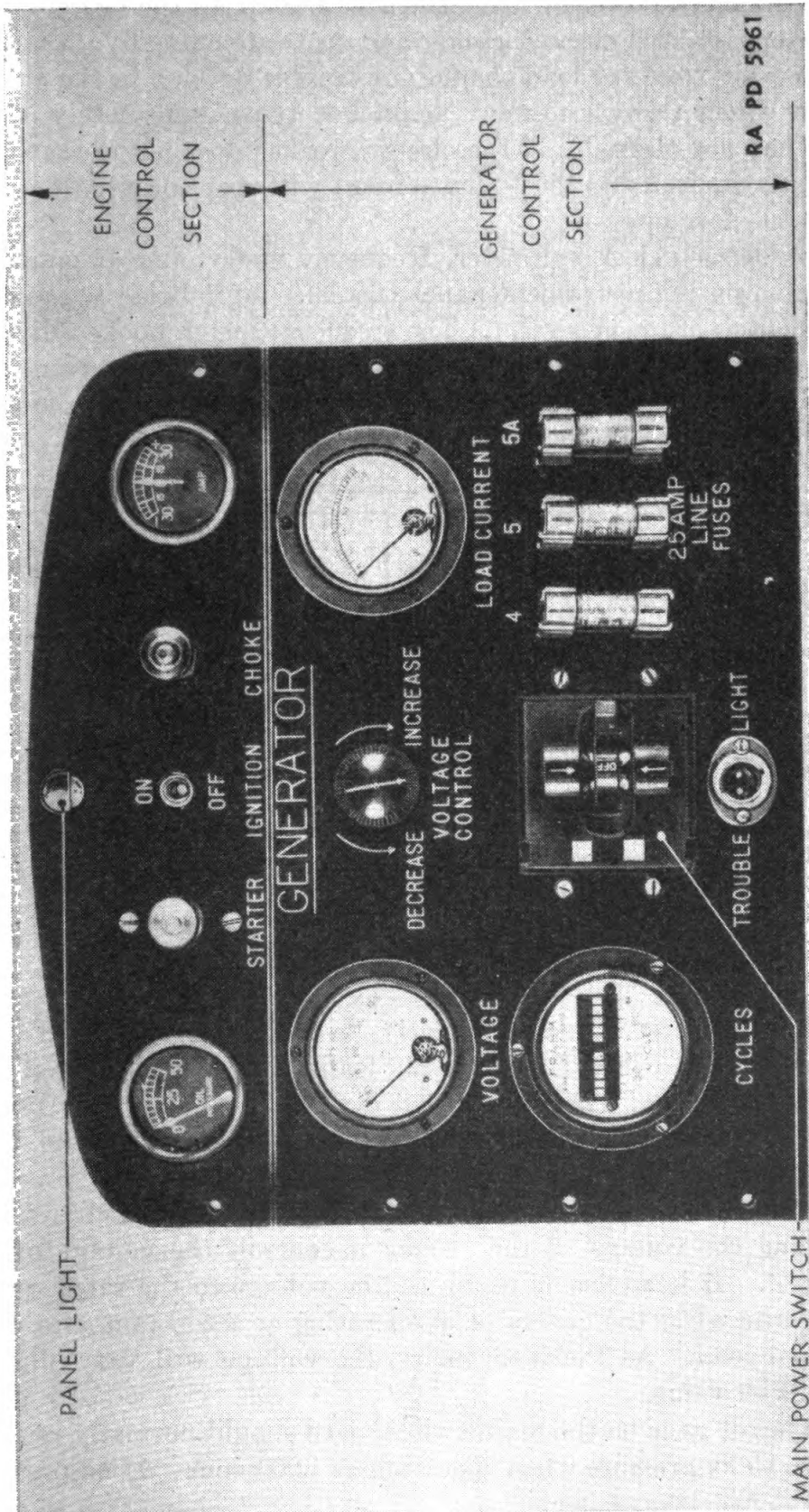
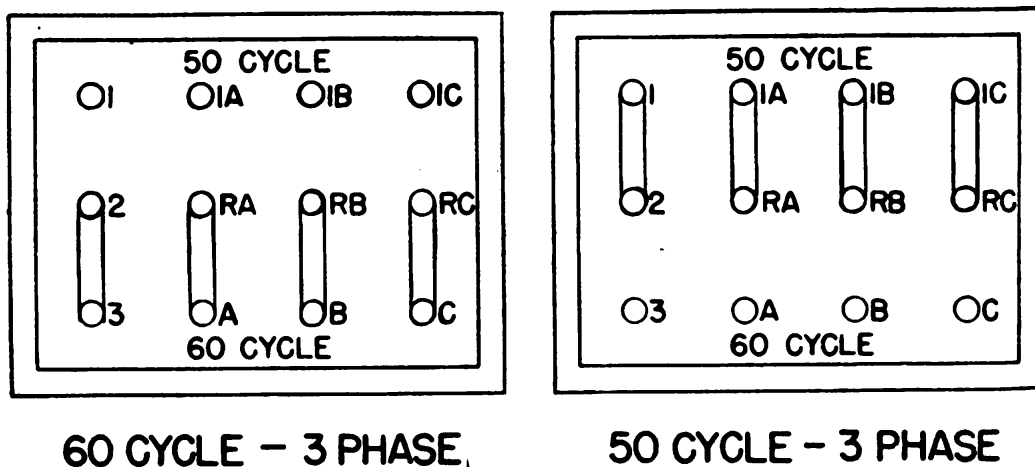


FIGURE 110.—Generating unit M5—instrument panel.

closing the main power switch, which is located on the switchboard. This switch is also a circuit breaker and will automatically disconnect the generator from the load should any trouble develop in the circuit. It resets when thrown to "on" again but trips immediately if the trouble has not cleared. If the circuit breaker does not operate, the three fuses connected in the 3-phase circuit will open the circuit should any trouble develop.

*d. Controls.*—(1) A voltmeter, frequency meter, and an ammeter are located on the instrument panel (fig. 110) to indicate the operating conditions of the generator. The frequency meter, hooked directly in the circuit with the voltmeter, will read the frequency continuously. Normally there will be from one to three cycles change in frequency as the load is placed on the unit.



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FIGURE 111.—Generating unit M5—arrangement of subpanel links for 60-cycle operation.

(2) The ammeter is placed directly in one main line and gives a direct indication of load. Normal full load rating for a balanced load is 13.9 amperes and 125 volts on 60 cycles. This unit will not be harmed if run for as much as two hours at 25 percent overload (17.4 amperes).

(3) The field rheostat is connected in the exciter field circuit and by varying the voltage of the exciter it controls the voltage of the entire unit. It is advisable to adjust the voltage to the rated or the desired value after the generator is operating at a constant rate, with its normal load. As the load varies, the voltage will vary slightly about this set value.

(4) The oil gage on the main switchboard should normally register from 5 to 15 lb. pressure when operating at 1,200 rpm. If no pressure

is indicated, stop the machine at once and investigate the trouble. When first starting the engine, or when the engine is cold, the pressure will be above 15 lb. but should come down to normal operating pressures as the engine warms up.

*e. To stop the unit.*—To stop the unit, first open the main power switch and then turn the ignition switch to “off.” Always make sure the main switch is open when connecting or disconnecting the cables.

**110. Generating unit care and preservation.**—*a. Adjustments.*—The following are adjustments that can be made in the field:

(1) *Fan belt.*—The fan belt should be kept in proper adjustment. The belt is tight enough when it can be deflected about one inch when grasping it midway between the pulleys.

(2) *Carburetor.*—The carburetor has no adjustments for gas mixture as this is determined and fixed at the factory. Its only adjustment is for idle speed, which should be set with main generator switch open, that is, when there is no load on the generator. To do this, hold the throttle lever against the idle speed stop by hand, with the engine at operating temperature, and adjust the idle screw so that the frequency meter reads 48 cycles or slightly less. If the engine operation should indicate too lean or too rich a mixture, it will be necessary to have the carburetor disassembled and thoroughly cleaned. This should be done only by qualified personnel.

(3) *Generator.*—As the commutator and slip ring brushes wear, it may be necessary to adjust the brush tension spring to compensate for this. If the brushes wear to the point that they are flush with the top of the brush holder box, they should be replaced. Normally, this will not occur until after two or three years of operation.

*b. Lubrication.*—Lubricating chart, Generating unit M5.

Part	Frequency	Lubricant	Quantity & Application
Ac Generator	200 hours' operation.	Grease, lubricating, special (grease, special, low temperature).	One turn of grease cup cap each bearing. Keep grease cup filled.
Water pump	do	Grease, water-pump, hard.	One turn of grease cup cap. Keep grease cup filled.



Part	Frequency	Lubricant	Quantity & Application
Crankcase-----	50 hours' operation.	Oil, engine <sup>1</sup> -----	Drain and refill through breather tube as required to maintain level at least three-fourths full on bayonet gage; capacity 2 qt.
Fan-----	do-----	do-----	Remove plug in hub. Fill until oil drips from shaft.
Starter-----	do-----	do-----	Few drops in oilhole.
Charging generator	do-----	do-----	8 to 10 drops in oil cup at each end.
Oil filter-----	150 hours' operation; oftener if oil becomes dirty.	-----	Renew refill cartridge.
Distributor-----	do-----	Oil, engine <sup>1</sup> -----	Few drops in oiler.
Breaker mechanism.	50 hours-----	Grease, water-pump, hard.	Wipe breaker cam lightly with grease.
	do-----	Oil, engine <sup>1</sup> -----	One drop on breaker cam pivot pin.
Air filter-----	Once a day in dusty conditions to once a week where little dust is encountered.	do-----	Remove oil cup; empty and refill with fresh oil.
Governor linkage.	Occasionally-----	do-----	Few drops on joints.
Commutators and slip rings.	Do not lubricate under any circumstances.		
Automatic choke.			

<sup>1</sup> Oil, engine, SAE 30 for temperatures above 32° F.

Oil, engine, SAE 10 or SAE 30 for temperatures between 32° F. and 10° F.

Oil, engine, SAE 10 for temperature between +10° F. and -10° F.

Below -10° F., dilute the crankcase oil with 10 percent gasoline or kerosene, or 15 percent Diesel fuel. Care must be taken to maintain the diluent at this ratio since it will be partially driven off during operation. In extremely low temperatures, if circumstances permit, drain the crankcase while the unit is warm and heat oil, before replacing, to temperature where hand can first be inserted without burning. Change oil every 50 hours of operation.

*c. Service and inspection.*—(1) The storage battery should be inspected every few weeks and distilled water added if necessary. The water level should always be above the top of the battery plates.

(2) The glass bowl of the gasoline filter should be removed occasionally and any dirt or water trapped therein removed.

(3) Add water to the radiator as often as necessary to maintain the water at the proper level. The water should be visible through the radiator cap opening.



FIGURE 112.—Cable repair kit M3—tool box.

**111. Kit, cable repair, M3.**—*a.* The cable repair kit M3 (figs. 112 and 113) is for use in repairing cables of the remote control system M1. It consists of a conventional portable tool box containing a vulcanizer and various tools and supplies necessary to make electrical connections and sheath repairs on multiple conductor transmission cables. A complete set of instructions and a list of the equipment are included in each kit.

b. The vulcanizer and soldering iron of the kit are electrically operated from power supplied by the generating unit (par. 109). The



FIGURE 113.—Cable repair kit M3—contents.

generating unit at present has no receptacle to receive the connecting plugs of these tools, but will be modified in the near future to provide



suitable receptacles. Until these receptacles are added, an emergency connection can be made by connecting the appliance wires to the binding posts on the rear of the instrument panel voltmeter. With this emergency connection the main switch does not control the power, so that the generating unit must be shut down when connecting or disconnecting the wires.

**112. Sights, direct fire.**—*a.* These sights (fig. 114) are used when the director is not available. The sights provide a simple means of giving the necessary lead to allow for target motion during the time of flight of the shell, and of changing the lead quickly during the engagement owing to the change in position of the target.

*b.* Both the traversing and elevating sights are of the "wheel" type with a clock face on which the course of the target is interpreted in terms of a clock hour.

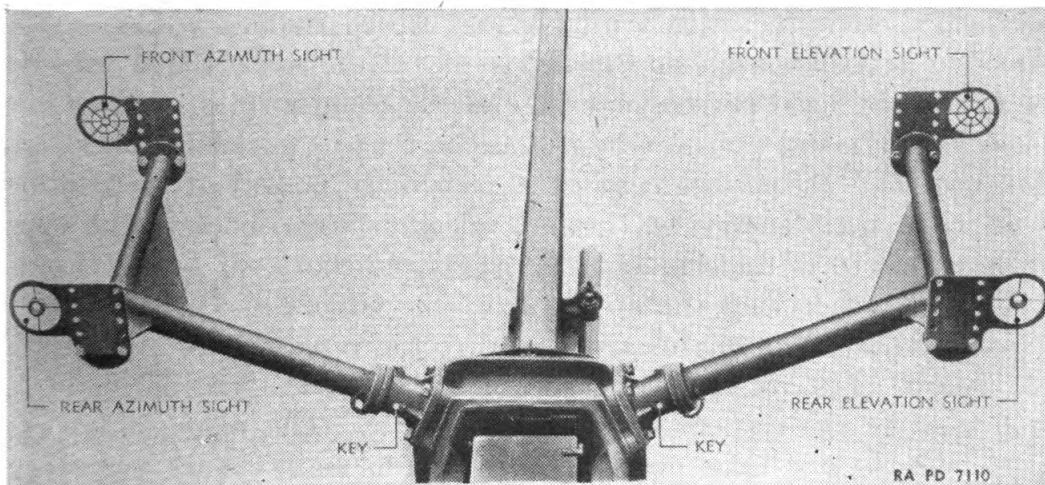


FIGURE 114.—Direct fire sights.

*c.* The sights fit into sight brackets on the gun cradle and are each secured by means of a rectangular sight key. The sights are readily removable for traveling.

*d.* When using these sights, the traversing and elevating hand cranks must be engaged (pushed in) and the oil gears of the remote control system must be disengaged. To disengage the oil gears, pull back the azimuth oil gear clutch operating handle, throw the elevation limit switch to "off" position, and disengage the elevation oil gear clutch lever (top of lever moved toward coupling), locking it by means of the auxiliary lever.

*e.* Leads and deflections are set by tracking the target at different points on the front sight cross wires, in accordance with the practice of the using arm.



*f.* The sights are ruggedly constructed, but because of their exposed position must be protected against damage by bending. The sights should not be used as handholds or supports.

**113. Maintenance and repair.—*a. Policy.***—The policy in regard to disassembly, repair, maintenance, and adjustments for all sighting and fire control instruments is as described below.

(1) Except as authorized in (2) below, disassembly and assembly of instruments by the using arms are, in general, not permitted beyond the extent authorized in the paragraph dealing with the individual instruments.

(2) In general, battery operating personnel are limited to adjustments, repairs, and maintenance of directors and similar intricate matériel which can be performed with facilities available and which do not require access to the interior of the instrument through removal of cover plates. Adjustments, repairs, and maintenance which can be performed with facilities available and which require access to the interior of the instrument through removal of cover plates may be performed by local personnel, either of the using arm or of the Ordnance Department, who have been qualified for this work either through the successful accomplishment of a recognized course of instruction in director maintenance or through adequate experience in the type of operation to be undertaken. A recognized course of instruction is defined as one having the approval of the Chiefs of Ordnance and Coast Artillery for qualification in director repair. See paragraph (3) below. Determination of adequate experience will be made in each case by the responsible ordnance officer. The responsible ordnance officer will take necessary action for maintenance requiring facilities beyond those available locally.

(3) Personnel possessing certificates of successful accomplishment of any of the following courses of instruction are authorized to perform routine maintenance and servicing of antiaircraft directors:

(*a*) Antiaircraft Fire Control Course, Enlisted Specialists' Division, The Coast Artillery School.

(*b*) Manufacturer's director maintenance course.

(*c*) Instruction course in director repair at the Ordnance School.

*b. Trouble shooting.*—(1) The procedure for the using personnel in case of malfunction of any part of the remote control system is to attempt to locate the major unit in which the fault originates. When the unit at fault is located, a single repair, such as replacement of a blown fuse, may be all that is necessary to restore the system to satisfactory operation. More extensive repairs requiring access to the interior through removal of cover plates are to be performed only by

qualified personnel. Faults which may arise in the individual units and permissible methods of correcting them are indicated in the paragraphs covering the separate units.

(2) Faults which originate in the generating unit, director, or connecting cables will affect the remote control system as a whole, and may sometimes appear to be due to faulty oil gears or other units which are not actually at fault. Similarly, certain faults at the director may evidence themselves by faulty operation at the gun.

(3) Faults which originate in the generating unit or its connecting cable are characterized by faulty operation at the director and at the gun, in both azimuth and elevation.

(4) Faults which originate in the director or its connecting cable are characterized by faulty operation in either azimuth or elevation elements, but very seldom in both elements. The fault will generally be noticeable to both the gun and director. For example, jerky following of the gun in azimuth accompanied by a similar jerky motion at the director will indicate a director fault (probably a defective azimuth torque amplifier), replacement of which can be accomplished only by qualified personnel.

## SECTION XII

### AMMUNITION

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**114. General.**—*a.* Ammunition for the 37-mm automatic AA gun M1A2 is issued in the form of fuzed, complete rounds of fixed ammunition. A round consists of a primer and propelling charge contained in a cartridge case, which is crimped rigidly to the projectile. The term “fixed” used in connection with ammunition signifies that the propelling charge is fixed (not adjustable) and that the round is loaded into the gun as a unit.

*b.* Ammunition for the water-cooled flexible caliber .50 Browning machine gun M2 and subcaliber .30 Browning machine gun M1917A1 is issued as fixed cartridges in cartons and boxes. A belt-loading

machine is provided for placing the subcaliber, caliber .30 cartridges into the machine-gun belt.

**115. Firing tables.**—For applicable firing tables see the appendix.

**116. Classification.**—*a. General.*—Dependent upon the type of projectile, ammunition for the 37-mm AA gun is classified as high-explosive, armor-piercing, and target-practice. High-explosive projectiles are filled with a high-explosive bursting charge. Armor-piercing projectiles are either solid shot containing no explosive, or thick-walled shells containing a small amount of high explosive. They are used for penetrating armor plate. Target-practice projectiles consist of a steel body, contain a dummy fuze and no loading, and are of the same size, shape, and weight as service shells.

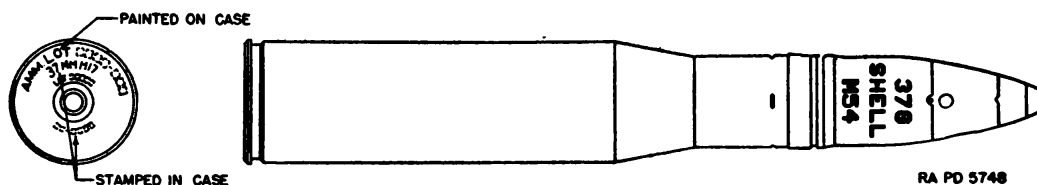


FIGURE 115.—Shell, fixed, HE, M54, with SD tracer and PDF M56, 37-mm automatic gun M1A2.

*b. Cartridges.*—Cartridges for the two types of machine guns used on the M3, M3E1, and M3A1 carriages for the 37-mm gun are classified as ball, tracer, and armor-piercing.

(1) Ball-type ammunition is for use against personnel and light matériel targets.

(2) Armor-piercing type ammunition is for use against armored aircraft, armored vehicles, concrete shelters, and similar bullet-resisting targets.

(3) Tracer-type ammunition is used for observation of fire.

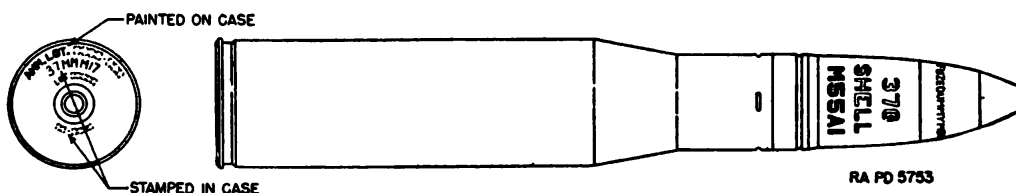


FIGURE 116.—Shell, fixed, practice, M55A1, with tracer and fuze, dummy, M50, 37-mm automatic gun M1A2.

**117. Identification and marking.**—*a. General.*—Ammunition, including components, is completely identified by means of painting and marking. Other essential information, such as weight zone and muzzle velocity, may also be obtained from the marking and from data cards.

*b. Mark or model.*—To identify a particular design, model numbers are assigned at the time the design is classified as an adopted type. This model designation becomes an essential part of the standard nomenclature and is included in the marking on the item. The present method of model designation consists of the letter M followed by an Arabic numeral. Modifications are indicated by adding the letter A and appropriate Arabic numerals. Thus M43A1 is the first modification of an item for which the original designation was M43. Prior to July 1, 1925 it was the practice to assign mark numbers. The word "mark" (abbreviated "Mk.") was followed by a Roman numeral, for example: Shell, HE, Mk. I. The first modification of a model was indicated by the addition of MI to the mark number, the second by MII, etc.

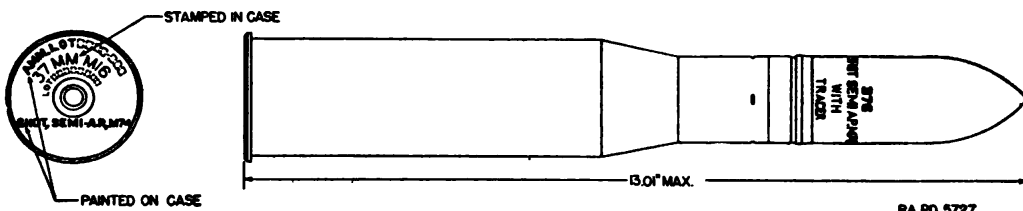


FIGURE 117.—Shot, semi-AP, M74, 37-mm automatic gun M1A2.

*c. Ammunition lot number.*—A lot number is assigned all ammunition at the time of manufacture. It is stamped or marked on every loaded complete round, on all packing containers, and on the accompanying ammunition data card. It is required for all purposes of record, including reports on condition, functioning, and accidents in which the ammunition is involved.

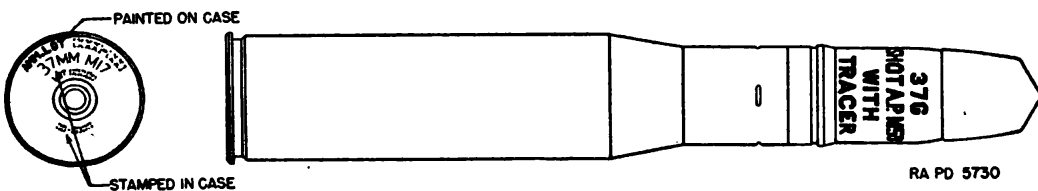


FIGURE 118.—Shot, AP, M59, 37-mm automatic gun M1A2.

*d. Ammunition data card.*—A 5- by 8-inch card, containing all the necessary information for complete and proper identification of the item or component, is prepared for each lot of ammunition. Copies of the data card accompany shipments of the ammunition or its components.

*e. Painting and marking.*—(1) *Painting.*—All projectiles are painted to prevent rust and to provide a ready means for identification through the color. The color scheme is as follows:

(a) High-explosive—Yellow.



(b) Practice—Blue.

(c) Armor-piercing shot—Black.

(2) *Marking.*—(a) The following information is stenciled on the projectile as illustrated in figure 115:

1. Kind of filler (for example, "TNT").
2. Model of projectile.
3. "SDT" (shell destroying tracer) or "TRACER."
4. Lot number of the loaded projectile.

Because the lot number of the loaded projectile is ordinarily not required after the complete round has been assembled, it is stenciled below the rotating band, in which position it is covered by the neck of the cartridge case.

(b) The following is stenciled in black on the base of the cartridge case: Ammunition lot number.

*f. Marking of cartridges.*—Caliber .50 cartridges are not stamped or marked to indicate type or model; however, they may be identified by the following marks:

(1) *Ball.*—Ball ammunition can be identified by the bullet, which has an unpainted gilding metal jacket.

(2) *Armor-piercing.*—Armor-piercing ammunition has  $\frac{7}{16}$  inch of the tip of the nose painted black.

(3) *Tracer.*—Tracer ammunition has  $\frac{7}{16}$  inch of the tip of the nose painted red.

See fig. 119 for further information on marking of cartridges. Markings of caliber .30 cartridges are given under subcaliber ammunition. (See par. 122.)

**118. Care, handling, and preservation.**—*a.* Complete rounds and ammunition components are packed to withstand conditions usually found in the field. Nevertheless, since explosives are adversely affected by moisture and high temperature, due consideration should be given to the following:

(1) Do not break the moisture-resistant seal until the ammunition is to be used.

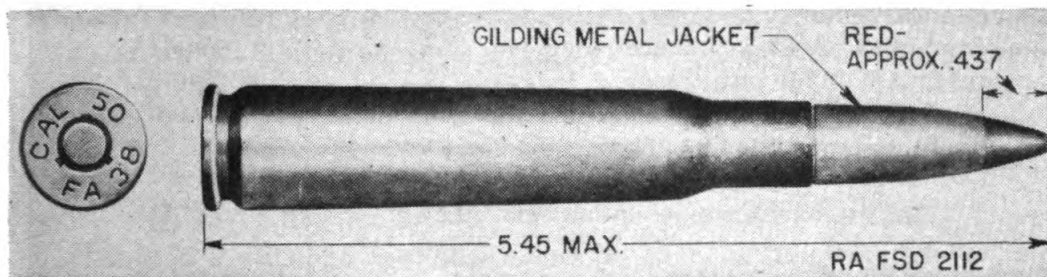
(2) Protect ammunition, particularly fuzes, from high temperature, including direct rays of the sun. More uniform firing is obtained if all rounds are at the same temperature.

*b.* Do not attempt to disassemble any fuze.

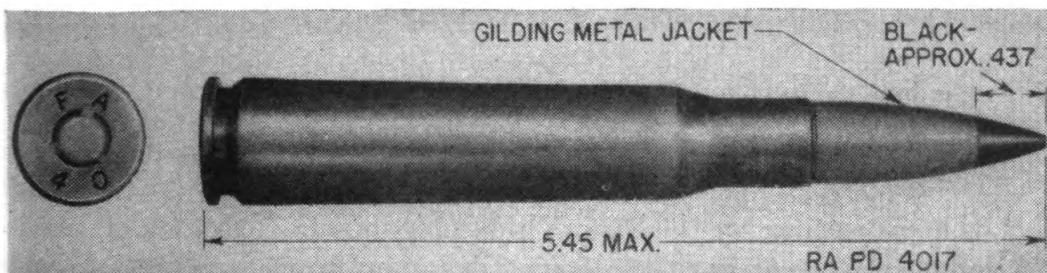
*c.* Before loading, the complete round should be free of foreign matter, sand, mud, moisture, grease, etc.

*d.* Do not remove protection or safety devices from fuzes until just before use.

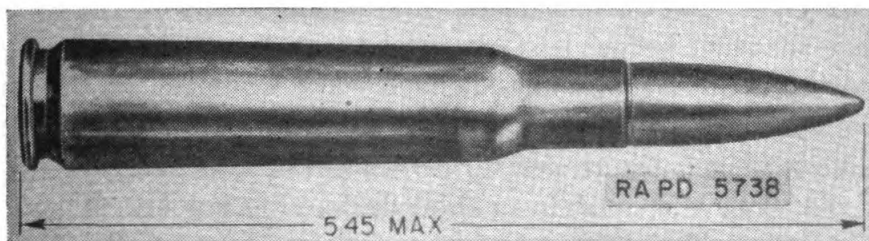
e. Rounds prepared for firing but not fired will be returned to original condition and packings and marked appropriately. Such components will be used first in subsequent firings, in order that stocks of opened packings may be kept at a minimum.



① Tracer, caliber .50, M1.



② AP, caliber .50, M1.



③ Ball, caliber .50, M2.

FIGURE 119.—Cartridges.

**119. Authorized rounds.**—a. Ammunition authorized for use with the matériel is shown in the following table. The model, the type, and the kind of fuze of a projectile, besides the model and type of a cartridge, are completely identified by the designation. The caliber .50 ammunition is authorized for use in the caliber .50 machine guns, mounted as substitute standard on the M3E1 carriage, pending procurement of 37-mm guns.

Weapon and ammunition	Weight of projectile
<i>37-mm gun M1A2</i>	
Shell, fixed HE, M54 with SD tracer and fuze, PD, M56 supersensitive fuze.	1.34 pound.
Shot, fixed, APC, M59 with tracer (red)-----	1.9 pound.
Shot, fixed, AP, M74, with tracer-----	1.92 pound.
Shell, fixed, practice, M55A1, with tracer and fuze, dummy, M50 (red) (no SDT).	1.34 pound.
<i>Caliber .50, Browning machine gun M2</i>	
Cartridge, AP, caliber .50, M2, with red tracer-----	1,803 grains.
Cartridge, ball, caliber .50, M2, with red tracer-----	1,776 grains.
Cartridge, tracer, caliber .50, M1, with red tracer-----	1,757 grains.
<i>Subcaliber, caliber .30, machine gun M1917A1</i>	
Cartridge, ball, caliber .30, M2, no tracer-----	174 grains. (Complete round.)

b. HE projectiles for the 37-mm gun have impact fuzes, which cause the detonation of the high-explosive filler upon impact with the target or other resistant object. Shell, fixed, HE, M54 contains a point-detonating fuze and a tracer (of the shell-destroying tracer type). When this tracer has burned its maximum time it sets off the detonator, exploding the shell before it strikes the ground.

c. Tracers are used in some shells for the observation of fire. In certain models, when the fuze fails to function or the projectile fails to strike the target, the tracer ignites the filler and destroys the shell. Shell, fixed, HE, MS, contains a shell-destroying tracer. These tracer shells (and cartridges), as a check on the accuracy of the firing, will usually be fired every third, fourth, or fifth round.

d. The propelling charge used in these shells is flashless nonhygroscopic powder (FNH), giving a prescribed muzzle velocity of 2,600 feet per second for shells and 2,050 feet per second for armor-piercing projectiles.

e. The armor-piercing shell authorized for use in the 37-mm anti-aircraft gun is shot, AP, M59, and shot, AP, M74, with tracer.

f. The standard ball and AP caliber .50 ammunition fired in the Browning machine gun M2 has a muzzle velocity of approximately 2,900 feet per second and a maximum range of approximately 7,200 yards. The tracer ammunition has a lighter bullet and a corre-

spondingly reduced maximum velocity, so that the flight of the bullet is nearly the same as the ball and AP bullets for ranges of 1,000 yards or less.

NOTE.—When firing at low elevations, it is necessary to remove the trough under the 37-mm gun mechanism to prevent the empty cartridges from falling back into the mechanism.

**120. Fuzes.**—*a. General.*—A fuze is a mechanical device used with a projectile to explode it at the time and under the circumstances desired.

*b. Classification.*—Fuzes are classified according to their manner of action as “time” or “impact.” Time fuzes contain a graduated time element in the form of a compressed powder train or a mechanism similar to clockwork which is set to explode the shell a certain number of seconds after firing. Impact fuzes function when the projectile strikes a resistant object. Further subdivision of the impact types is dependent upon rapidity of action. The classifications are “super-quick,” “nondelay,” and “short delay.”

*c. Point-detonating fuzes.*—The 37-mm high-explosive projectile fired in this gun uses a supersensitive point-detonating fuze which explodes even on contact with a very light material such as airplane wing fabric. Fuze, dummy, M50, consists of aluminum alloy metal, cut to give the same contour and weight as fuze, PD, M56. It is used on the M55A1 shell to fulfill weight requirements.

*d. Arming.*—Arming of an artillery impact fuze is the process by which certain mechanical elements of a fuze are changed in position to prepare the fuze for functioning. The forces utilized in arming are centrifugal force and set-back. The fuze becomes fully armed after the projectile leaves the muzzle of the gun. Time fuzes in a strict sense are always armed; they start functioning by the action of set-back at the instant of firing the gun.

*e. Boresafe fuzes.*—Certain fuzes are considered boresafe. A boresafe (detonator-safe) fuze is one in which the explosive train is so interrupted that prior to firing, while the projectile is still in the bore of the cannon, premature action of the bursting charge is prevented should any of the more sensitive elements, primer and/or detonator, malfunction.

**121. Packing.**—*a.* Complete packing data covering dimensions, volume, and weight of the ammunition described herein are published in page 2, part II, SNL P-4. The following data are useful in estimating weight and volume requirements:

*Ammunition for 37-mm automatic gun M1A2:*

(1) Shell, fixed, HE, M54, with SD tracer and fuze, PD, M56.



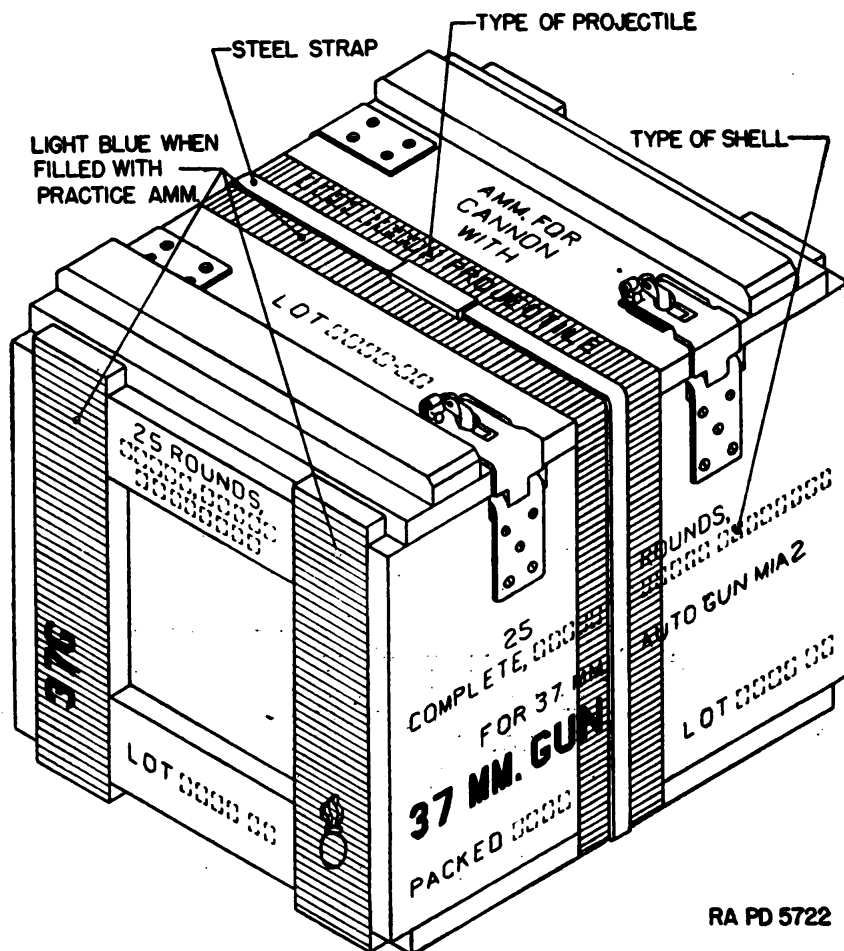
(2) Shell, fixed, practice, M55A1, with tracer and fuze, dummy, M50, 37-mm automatic gun M1A2.

(3) Shot, fixed, APC, M59, with tracer, 37-mm automatic gun, M1A2.

(4) Shot, fixed AP, M74, with SD tracer. M56.

Rounds and packing	Dimensions			
	Inches	Square feet	Cubic feet	Weight
20 in metal-lined box	17 $\frac{1}{8}$ by 12 $\frac{1}{16}$ by 16 $\frac{1}{32}$	1. 54	2. 09	85
25 rounds per box	17 by 13 $\frac{1}{16}$ by 15 $\frac{1}{32}$	1. 64	2. 06	99

b. Boxes containing the practice ammunition are marked with a blue band as shown in figure 120.



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FIGURE 120.—37-mm ammunition packing box.

*c. Packing for .50 caliber ammunition.*—Ammunition listed under authorized rounds of this caliber is marked as shown in figure 121. Information given in the following table will be found useful in estimating packing requirements. Further information for packing caliber .50 ammunition will be found on page 2, part II, SNL T-1.

*Ammunition for caliber .50, Browning machine-gun, M2.*

(1) *Cartridge, ball, caliber .50, M1.*

Rounds and packing	Dimensions			
	Inches	Square feet	Cubic feet	Weight
10 per carton, 30 cartons (300 rounds) per metal-lined box.	18 $\frac{7}{16}$ by 9 $\frac{9}{16}$ by 14 $\frac{13}{16}$ .	1. 21	1. 49	102
10 per carton, 35 cartons (350 rounds) per box.	18 $\frac{7}{16}$ by 9 $\frac{9}{16}$ by 14 $\frac{13}{16}$ .	1. 21	1. 49	114
100 in link belt, 1 loaded belt per carton, 200 rounds per box.	18 $\frac{7}{16}$ by 9 $\frac{9}{16}$ by 14 $\frac{13}{16}$ .	1. 21	1. 49	71
100 cartridges (79 ball and 21 tracer) in link belt, 1 per carton, per box.	18 $\frac{7}{16}$ by 9 $\frac{9}{16}$ by 14 $\frac{13}{16}$ .	1. 21	1. 49	71

(2) *Cartridge, tracer, caliber .50, M1.*

Rounds and packing	Dimensions			
	Inches	Square feet	Cubic feet	Weight
10 per carton, 31 cartons (300 rounds) per metal-lined box.	18 $\frac{7}{16}$ by 9 $\frac{9}{16}$ by 14 $\frac{13}{16}$ .	1. 21	1. 49	100
10 per carton, 35 cartons (350 rounds) per box.	18 $\frac{7}{16}$ by 9 $\frac{9}{16}$ by 14 $\frac{13}{16}$ .	1. 21	1. 49	111

*d. Boxes containing caliber .50 ammunition* are marked with a primary red band. Tracer ammunition boxes are marked with a yellow band, on which is painted a green band. Ball and tracer caliber .50 ammunition is marked with a yellow, red, and green (3 stripes) band. Marking runs diagonally on the box. Design of the packing boxes may be seen in figure 121.

**122. Subcaliber ammunition.**—*a. General.*—Cartridge, ball, caliber .30, is used with the subcaliber, caliber .30 Browning machine gun M1917A1 mounted on the M3 and M3A1 carriages. This ammunition has no identifying paint on the bullet. It is packed in web or link belts. These belts are packed in metal-lined boxes.



FIGURE 121.—Packing box for cartridge, ball, caliber .50, M1.

*b. Packing data.*

Rounds and packing	Dimensions			
	Inches	Square feet	Cubic feet	Weight
Cartridge, ball, caliber .30, M2 ----- Packed 250 per machine-gun belt, 5 belts (1,250 rounds) per metal-lined box.	$18\frac{7}{16}$ by $9\frac{9}{16}$ by $14\frac{13}{16}$ .	1. 21	1. 49	96
Cartridge, ball, caliber .30, M2 ----- Packed 20 per carton, 75 cartons (1,500 rounds) per metal-lined box.	$18\frac{7}{16}$ by $9\frac{9}{16}$ by $14\frac{13}{16}$ .	1. 21	1. 49	110

**NOTE.**—The M2 cartridge is similar to the M1, but may be distinguished by its bullets, which have tin-coated jackets. The container is marked M2, and 38 or a higher number is stamped on the cartridge case.

*c. Packing and marking of subcaliber ammunition.*—Tracer ammunition is marked with a yellow band on the box. Boxes of ball ammunition containing links with tracer and ball shells have the box painted with a three-stripe band of yellow, red, and green. Ball ammunition in cartons is marked with a red band around the carton.

The type of box in which caliber .30 ammunition is packed is shown in figure 122.

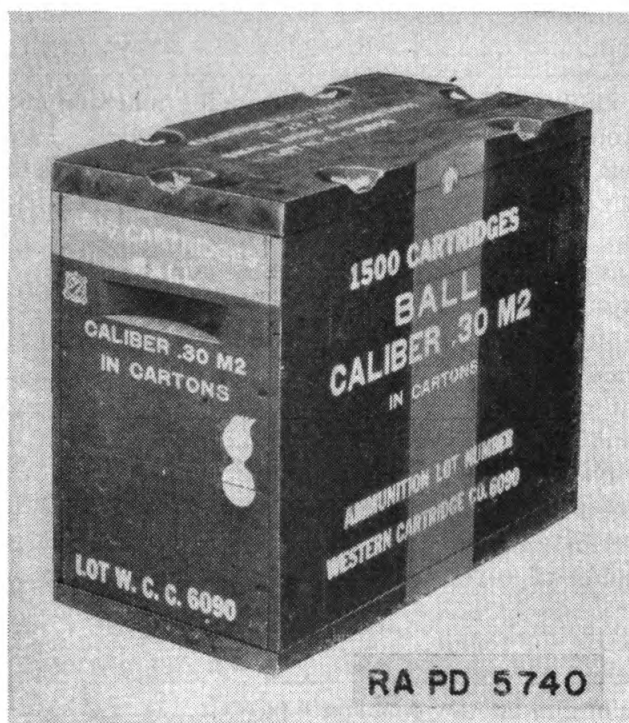


FIGURE 122.—Packing box for cartridge, caliber .30, M2.

**123. Field report of accidents.**—Any serious malfunctions of ammunition must be promptly reported to the ordnance officer under whose supervision the matériel is issued and maintained (AR 45-30).



## SECTION XIII

## SUBCALIBER EQUIPMENT FOR M3 and M3A1 CARRIAGES

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**124. Purpose.**—Subcaliber equipment, which is used for training purposes only and is not taken into the theater of operations, consists of the subcaliber, caliber .30, Browning, water-cooled machine gun M1917A1; the subcaliber mounts M8 and T10, and accessories. This equipment is used to provide practice in laying and firing the 37-mm matériel. The use of small-bore ammunition prevents wear on the regular piece during practice and is less costly. The actual handling, loading, and range obtained are different between the subcaliber and service matériel.

**125. General data for caliber .30 water-cooled Browning machine gun M1917A1.**

Weight of gun, without water (pounds)-----	32. 6
Weight of gun, with water (pounds)-----	41. 0
Weight of belt, empty (ounces)-----	7. 5
Weight of belt, filled, 250 rounds in chest (pounds)-----	20. 50
Length of barrel (inches)-----	24. 00
Rate of fire (shots per minute)-----	400 to 525
Muzzle velocity, approximate (feet per second)---	2, 700

**126. Principle of gun operation.**—The Browning machine gun, caliber .30, M1917, is recoil-operated, belt-fed, and water-cooled. In recoil operation the rearward force of the expanding powder gas (kick) furnishes the operating energy. The moving parts, while locked together at the moment of the explosion, are left free within the receiver to be forced to the rear by the recoil. This movement is controlled by various springs, cams, and levers and is utilized to perform the necessary mechanical operations of unlocking the breech, extracting and ejecting empty case, feeding in the new round, cocking, locking, and firing the mechanism.

**127. Gun cooling system.**—The barrel is surrounded by a water jacket which holds about 7 pints of water. The water absorbs the heat generated in firing the gun, preventing the barrel from becoming overheated. The steam escape tube located in the top of the water jacket consists of two tubes (inner and outer). On the top of both ends of the inner tube a hole is located. The outer tube, which slides freely on the inner, is of such length that it cannot cover both holes at the same time. Therefore, as the muzzle of the gun is elevated or depressed, gravity causes the outer tube to mask the lower hole and prevent the escape of water. The upper hole, which is uncovered by this movement, allows the steam generated, through firing, to escape through the inner tube and end cap to the condensing device, which is immersed in the water box.

**128. Feed belt.**—The feed belt is made of woven fabric with loops and has no metal parts except a brass strip at each end to facilitate loading.

**129. Mounting.**—The subcaliber Browning machine gun, caliber .30, M1917A1 is supported by the M8 mount on the M3 carriage and the T10 mount (now under development) on the M3A1 carriage. Both mounts are similar, differing only in the trigger mechanism and design of the brackets.

**130. Disassembly and assembly of caliber .30 machine gun.**—*a.* Disassembly may be considered under two general heads:

(1) Removal of the groups to the extent required for ordinary cleaning and minor repairs.

(2) Detailed disassembly, involving removal of all component parts of each group.

*b.* A group is a number of parts contained in a common housing which function as a unit.

*c.* The removal of the different groups from the gun and complete disassembly of the groups by the using arms can be accomplished with the tools provided.

*d.* The cover is raised by gripping the rear sight base.

*e.* A cartridge is the only tool required for the disassembly of the gun.

**131. Removal of groups from gun.**—*a. Backplate.*—(1) Pull back on the latch and raise the cover. With the left hand pull back the bolt handle and hold it in the rearmost position.

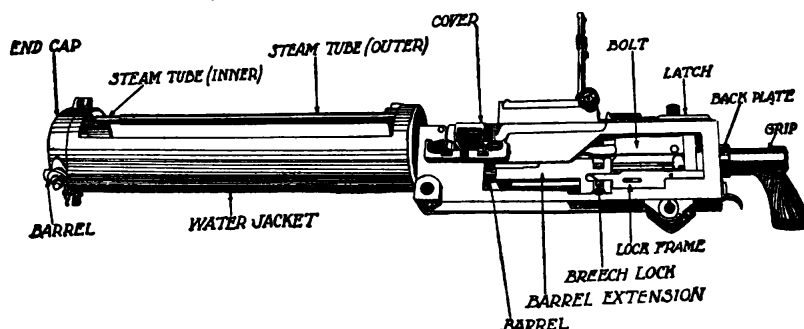


FIGURE 123.—Mechanism in backward position.

(2) Insert the rim of a cartridge in the end of the driving spring rod. With the slit horizontal, push in the driving spring rod as far as it will go and turn it clockwise one-quarter turn until the slit is vertical. In this position the legs on it will engage in their recesses in the bolt, locking the driving spring rod.

(3) To free the rear end of the driving spring rod from the backplate, push the bolt handle forward about an inch.

(4) Push the latch forward and lift out the backplate.

*b. Bolt handle.*—Pull the bolt by the handle all the way to the rear and pull the bolt handle out of the bolt.

*c. Bolt.*—Remove the bolt from the rear end of the receiver. *Be careful not to handle the driving spring rod.*

*d. Lock frame.*—Push in on the trigger pin through the hole on the right side of the receiver with the nose of a cartridge. Grasp

the trigger and pull the lock frame, barrel extension, and barrel out until the lower rear lugs on the barrel extension drop down behind the bottom plate. Hold the lock frame firmly and push forward on the accelerator; this snaps the lock frame and the barrel extension apart by a release of the lock frame spring.

*e. Barrel extension and barrel.*—(1) Remove the barrel extension and the barrel from the rear of the gun.

(2) Unscrew the barrel extension from the barrel.

*f. Latch* (containing latch spring).—Pull off the latch to the rear until it separates from the top plate.

*g. Cover.*—(1) Turn the cover pin spring up and remove the pin.

(2) Remove the cover.

(3) To prevent undue wear, the cover and latch should not be removed except when necessary for cleaning or replacement of parts.

**132. Replacing groups in gun.**—*a.* In general, the groups are replaced in the gun in reverse order.

*b.* Replace the cover. Insert the cover pin and lock it by turning the cover pin spring forward into its seat in the trunnion block.

*c.* Seat the rounded end of the latch spring in the seat, placing the hole in the spring over the pin, bent side of spring away from the latch. Push the latch on to the top plate from the rear, free end of spring, to the front. Push up on latch spring to start the free end of the spring over top plate, then force the latch home. If spring is allowed to slip from its seat, the latch will not function and the spring will jam the latch so that it cannot be removed without breaking.

*d.* Screw the barrel into the barrel extension until the barrel-locking spring begins to engage in the barrel notches.

*e.* Insert the barrel and barrel extension into the receiver until the lower rear lugs of the barrel extension are against the bottom plate.

*f.* Take the lock frame in both hands with the index fingers beneath and supporting the accelerator. Place the claws of the accelerator in front of and against the T-lug, allowing front end of trigger to slip over top of T-lug. At the same time, insert the front projections of the lock frame into the slots of the barrel extension and push forward until the accelerator moves backward against T-lug, compressing barrel plunger spring. This will lock the lock frame to the barrel extension. Push down the tips of the accelerator to insure positive locking.

*g.* Raise parts and push them into the gun. With the finger, force the trigger pin inward to clear it of the right side plate. Push forward until a click is heard as the trigger pin springs out into its seat in the right side plate.

h. Push cocking lever forward into slot provided in the bolt. Insert the bolt, holding down on the trigger. Tip the front end of the bolt upward by pressure downward on the trigger. This will prevent ejector from tripping the accelerator and cause the projections on each side of the bolt to run in their grooves in the barrel extension.

i. Insert the bolt handle through the large opening at the rear of the slot and push it forward about 1 inch, being sure that the collar on the handle is inside the right side plate. Be sure cover is up.

j. Push forward on latch and replace the backplate.

k. Hold the bolt handle fully back with the left hand. Place the rim of a cartridge in the slit in the end of the driving spring rod, and turn the rod one-quarter turn counterclockwise until the slit is horizontal. This releases the driving spring. Allow the bolt to go forward.

l. Make the head-space adjustment as follows:

(1) Pull the bolt to the rear about three-fourths of an inch.

(2) Screw the barrel into the barrel extension (by using the point of a cartridge or the combination tool in the barrel notches) until the action will just close (recoiling parts will go fully forward) without being forced.

(3) Then unscrew the barrel two notches.

**Caution:** Care must be exercised to avoid roughening the barrel surface during the adjustment. Also, the packing must not bind the barrel; a false adjustment will result in such binding.

m. *Quick head-space adjustment.*—After the head-space adjustment has been determined by the method described in l. above, the notch in which the barrel-locking spring is engaged may be marked with a center punch. To make the correct adjustment during the assembly of the gun—

(1) Screw the barrel all the way into the barrel extension.

(2) Then unscrew it until the barrel-locking spring is in the marked notch.

(3) Place the belt feed lever stud over the cam groove in the bolt and close the cover.

**133. Detailed disassembly of bolt (fig. 124).—a.** Turn extractor up and remove it to the left.

b. Great care should be exercised in removing the driving spring rod from the bolt as the force of the driving spring when released can easily cause the rod to slip from the hand, and possibly result in serious injury. To remove driving spring rod, place the protruding end of the rod on the table or a block of wood. With the bolt firmly grasped by the right hand (palm of hand over top of bolt), press down and



at the same time turn the bolt one-quarter turn to the left until the lugs on the rod leave their recess in the bolt. Slowly release pressure on the bolt, allowing it to rise under the action of the driving spring until about 3 inches of the rod protrude. With the left hand grasp the protruding portion of the rod and spring; raise both hands and the bolt from the table, keeping the rod and spring in their same position relative to the bolt. Separate the rod and spring from the bolt with a quick jerk. The quick, separating jerk will not allow the spring to kink. Separate the driving spring rod and the driving spring.

c. Turn the top of the cocking lever to the rear of the bolt and withdraw cocking lever pin to the left of the bolt.

d. Lift out the cocking lever.

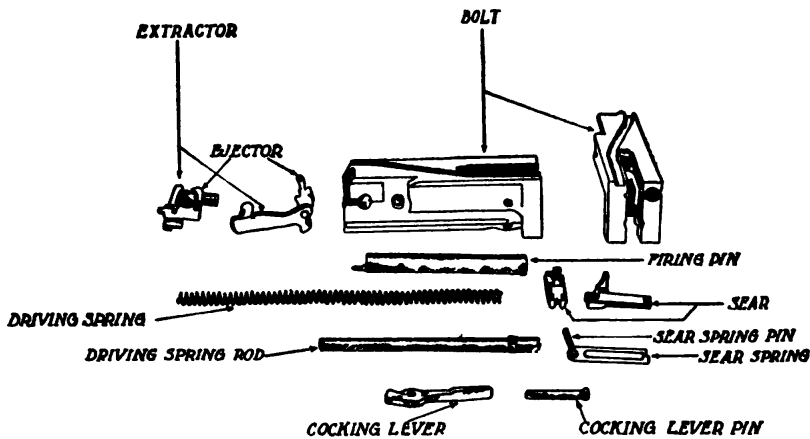


FIGURE 124.—Bolt group.

e. Release the firing pin by pushing down on the sear. Hold the bolt in the left hand, front end toward the body, top up, with index finger of the left hand beneath and supporting the sear. Use the nose of a cartridge placed near the end of sear spring to push downward and to the right on the spring to seat it in the cut in the bolt. This releases the sear which is removed at the bottom of the bolt.

f. Turn the sear spring back to the left to clear the cut. Push the nose of a cartridge into the hole in the bottom of the bolt to start the sear spring pin moving. To complete the removal of the sear spring, place the top end of the cocking lever in the slot in the rear of the bolt *well under sear spring* and pry up against the spring and down against the bolt.

g. Place the palm of the right hand over rear of the bolt, tilt the rear end of the bolt down, and the firing pin will fall out.

**134. Assembly of bolt.**—*a.* Place the firing pin in the bolt, striker downward and to the front; tilt front of bolt downward until the striker projects through the small hole in the front of the bolt.

*b.* Replace the sear spring by pushing with a cartridge on top of the pin, avoiding pressure on spring proper.

*c.* Hold the bolt in the left hand, front end toward the body, top up. With the point of a cartridge placed near the end of the sear spring, push downward and to the right to seat it in the cut in the bolt.

*d.* Push the sear upward from the bottom, notched projection to the front, and hold with first finger of the left hand; at the same time press downward and to the left on the sear spring with a cartridge, to engage the end of the sear spring in the sear.

*e.* Replace the cocking lever, making certain that the rounded nose on lower end is to the rear, so that it will properly engage in the recess in the firing pin.

*f.* Insert the cocking lever pin from the left side of the bolt. The upper end of the cocking lever should be to the rear of the bolt before inserting the pin, as this aligns the cocking lever for the return of the pin.

*g.* Cock by pressing forward on the cocking lever. Turn the cocking lever to the rear and press down on the sear with a cartridge to release the firing pin, and test the correctness of assembly.

*h.* The same care should be exercised in assembling the driving spring rod to the bolt that is exercised in removing it. Place the driving spring on the driving spring rod. With the back end of the rod resting on a table or a block of wood, gather as much of the spring on the rod as can be held compressed by the thumb and fingers of the left hand. With the bolt securely held in the right hand, front end of bolt in the palm of the hand, slip the bolt over the end of the spring. Push downward to compress the spring and allow the lugs on the rod to enter the slot in the bolt. Turn the bolt slowly 90° clockwise until the slit in the rod is crosswise to the slot in the bolt.

*i.* Insert the pin on the extractor into the rear one of the two large holes in the left side of the bolt, extractor pointing up. Turn the extractor downward toward the front to engage the collar on the extractor under the collar cut in the bolt.

**135. Detailed disassembly of lock frame (fig. 125).**—*a.* Grasp the head of the trigger pin between the thumb and first finger of the right hand and remove it to the right. If the pin is too tight to permit its removal in this manner it must be drifted out. Do not remove the trigger pin spring except when necessary.

*b.* Push out the accelerator pin and remove the accelerator.

*c.* Hold the lock frame with the left hand, projections pointing upward, slot to the left, separator between the second and third fingers, first and second fingers gripping the barrel plunger spring. With the thumb of the right hand, press down and out on the barrel plunger to disengage the plunger guide pin from the slot. Allow the spring, with the plunger, to rise slowly. Lift out the spring and remove it from the barrel plunger.

**136. Assembly of lock frame.**—*a.* Assemble the barrel plunger spring to the barrel plunger. Hold the lock frame with the left hand, projections pointing upward, slot to the left, lock frame separator

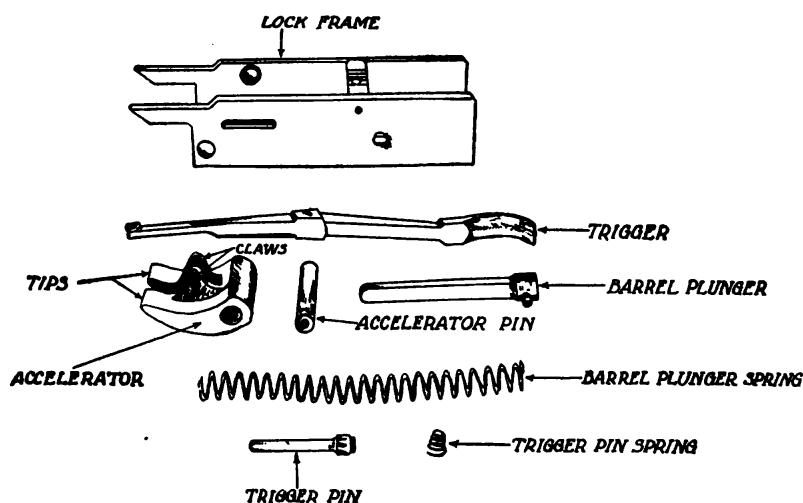


FIGURE 125.—Lock frame group.

between the second and third fingers. Seat the end of the barrel plunger spring in the recess in the lock frame separator, barrel plunger guide pin facing the slot in the lock frame. Using the first and second fingers of the left hand to prevent the spring from buckling, press down with the thumb of the right hand on the end of the barrel plunger until the barrel plunger guide pin can be seated in the slot. Care should be taken that the action of the spring does not cause the plunger to slip out of the hand.

*b.* Replace the accelerator with the tips up and the rounded surface to the front. Insert the accelerator pin, taking care that both ends of the pin are flush with the sides of the lock frame.

*c.* Push the front end of the trigger up between the separator and the spacer, placing the center in its square seating. If the trigger pin has been removed, seat the spring on the trigger pin, placing the small end of the spring toward the head of the pin. Replace the pin from the right.

**137. Detailed disassembly of barrel extension**—(fig. 126).—*a*. Insert the rim of a cartridge under the front edge of the barrel-locking spring and pull it out forward.

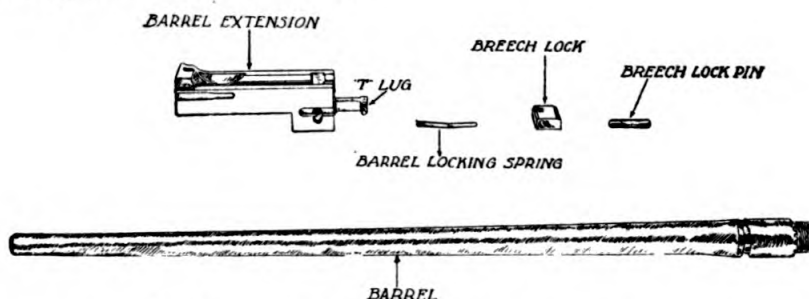


FIGURE 126.—Barrel extension group.

*b*. Push out the breech lock pin and remove the breech lock.

**138. Assembly of barrel extension**.—*a*. Place the breech lock in its slot, taking care that the double-beveled surface is up and to the

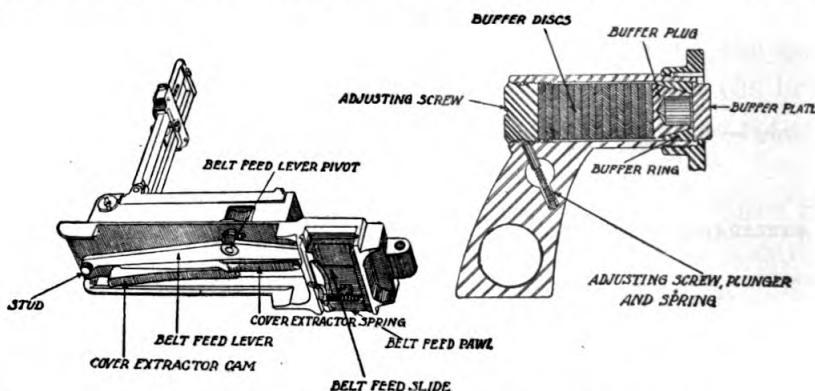


FIGURE 127.—Cover and shock-absorbing groups.

front. Insert the breech lock pin and insure that both ends of the pin are flush with the sides of the barrel extension.

*b*. Insert the barrel-locking spring in the seating in the left side of the barrel extension, hook inward, and force home as far as it will go.

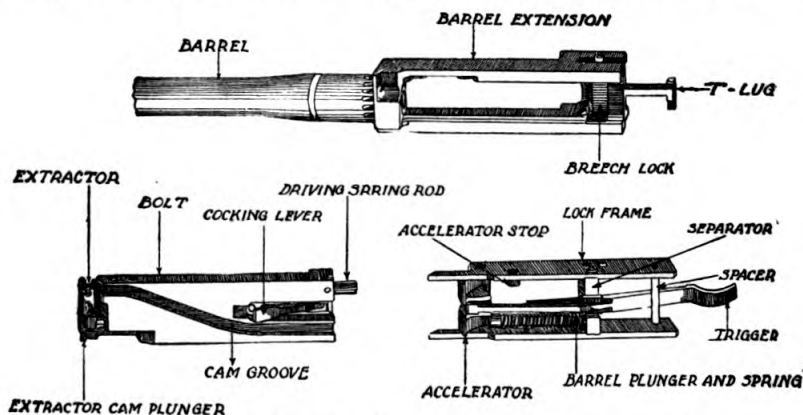


FIGURE 128.—Barrel extension, bolt, and lock frame group.

**139. Detailed disassembly of cover (fig. 127).—***a.* Turn the belt feed lever pivot spring outward and remove the belt feed lever pivot.

*b.* Withdraw the belt feed lever from the belt feed slide and remove the slide.

*c.* Insert the nose of cartridge between the cover extractor spring and the notch in cover extractor cam. With the thumb of the left hand over the spring, pry out on the spring to disengage it from the cut. Lift the spring from its seat against the stud.

**140. Assembly of cover.—***a.* Place the forked end of the cover extractor spring under the stud on the cover. Press downward with

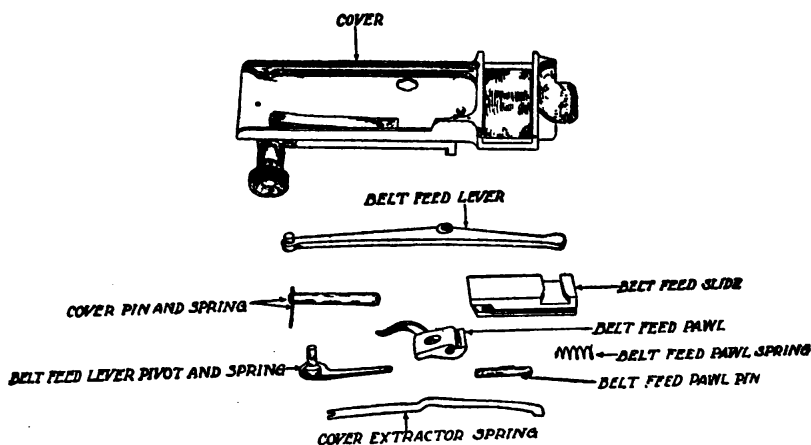


FIGURE 129.—Cover group.

the thumb on the other end of the spring, at the same time pushing toward the stud, and seat the projection of the spring in the notch of the cover extractor cam.

*b.* Replace the belt feed slide in its grooves in the cover, taking care that the pawl is pointing to the right as the cover goes on the gun.

*c.* Place the front end of the belt feed lever in the cut, stud on the lever away from the cover and to the rear. Insert the belt feed lever pivot so that the spring is at right angles to the cover and the lugs on the pivot pass through the cuts in the cover. Turn the spring inward toward the base of the rear sight until the lugs engage on the under side of the cover and the spring locks in place.

**141. Disassembly of parts for repair.—***a. Shock-absorbing group.*—Unscrew the adjusting screw and remove the adjusting screw plunger and spring. Remove the buffer disks, buffer plug, buffer ring, and the buffer plate through the rear end of the grip. Replace in the reverse order.

*b. Belt-holding pawl.*—(1) Hold down the belt-holding pawl and withdraw the belt-holding pawl split pin to the rear.



- (2) Lift off the belt-holding pawl.
- (3) Lift the belt-holding pawl spring from its seating.
- (4) Replace in the reverse order.

*c. Steam tube.*—(1) The steam tube need never be removed unless it becomes so clogged that steam will not pass off, or the outer tube becomes stuck so that it will not slide back and forth on the inner tube when the gun is held in the hands and tipped forward and backward. Great care must be used to prevent damage to the threads of the steam-tube front plug, and it should never be removed except under the supervision of an officer or by an experienced mechanic.

(2) Stand the gun with the muzzle up and water jacket vertical. Remove the steam-tube front plug screw. Place the large screw-driver blade of the combination tool in the slit and unscrew the steam-tube front plug until the threads are disengaged and the steam tube can be lifted out.

(3) To replace, stand the gun exactly vertical, as prescribed in (2) above, and insert the steam tube. Gently screw in the threads, stopping at once if there is any undue resistance. The gun and tube must be exactly vertical to insure that the conical end of the tube enters its seating in the trunnion block. Forcing the screw against resistance will damage the threads. If it does not screw in easily, unscrew a short distance, be sure the water jacket is vertical, and try again until threads screw in smoothly. Screw in tight without excessive force, and then place the notch in the rim of the plug exactly on the round countersunk recess for the front plug screw, unscrewing part of a turn if necessary. Replace the screw and screw it firmly down into its countersunk seating. If the notch in the rim is not engaged by the screw head, the steam tube will not be alined to permit the escape of steam through the end cap and the water jacket will burst from the steam generated in firing.

**142. General care of gun.**—It is essential that the gun be maintained in the best mechanical condition at all times; it must always be kept clean and covered with a light coating of oil. Care and cleaning will not be confined to the gun alone but will include the mount and all accessories. Belts and ammunition must be kept clean and dry.

**143. Care and cleaning of gun, mount, and spare parts.**—*a. Bore.*—When firing is completed, the bore should be cleaned without delay.

- (1) Disassemble the groups from the gun.
- (2) Place the barrel, with the barrel extension attached, muzzle down, in a vessel containing hot water and issue soap, a sal soda solution, or, lacking these, hot water alone. (It is most convenient to

clean the bore immediately after firing, as hot water is available in the water jacket.)

(3) Use the cleaning rod with a flannel patch to pump water back and forth through the bore for about 1 minute. (A soft wire brush may be used to remove particles which are stuck to the bore.)

(4) Dry and clean the bore thoroughly; then apply a light coat of lubricating oil.

(5) Inspect daily. If the bore is corroded, repeat the above treatment until the bore no longer shows any signs of corrosion.

*b. Moving parts.*—The moving parts should be kept clean and lubricated before, during, and after firing. In lubricating the parts during firing, care should be exercised to apply oil frequently but sparingly to those parts where actual friction exists. These include the cam groove, the cocking lever, and the muzzle gland packing. Excess oil generates smoke which interferes with observation of fire and tends to indicate the gun position. Avoid pulling a partly empty belt through the feed opening as the lint and dirt thus collected interfere with the functioning of the feed mechanism.

*c. Spare parts.*—The spare parts chest contains serviceable parts to replace those which become defective. It should, therefore, be kept complete at all times with its contents clean, serviceable, and lightly oiled. Replacement units, such as the spare bolt, should be ready for immediate use. Smaller parts should be kept in the fabric envelopes or containers to prevent loss. As a general rule, only one barrel should be in active use in the gun as long as it remains serviceable, the spare barrels being treated with rust-preventive compound and kept as a reserve supply.

**144. Points to be observed before and after firing.**—The following table of points to be observed before, and after firing will be found convenient as a guide for the proper care of the gun. It will also serve as a guide for inspection.

Part to be inspected	Before firing	After firing
Bore-----	Look through and clean----	Clean and lightly oil with a patch.
Muzzle gland. ----	Pack and tighten-----	Examine and tighten if required.
Moving parts, including feed mechanism.	Oil and test for worn or broken parts. See that parts function without excessive friction.	Remove bolt, lock frame, barrel extension, and barrel; clean, oil, replace, and release firing pin.

Part to be inspected	Before firing	After firing
Head space-----	Make correct adjustment. Test strength of barrel-locking spring.	Adjust correctly. Examine barrel-locking spring.
Packing-----	Examine for leakage or excessive friction.	Examine and replace if necessary.
Water-----	Fill water jacket; see that water plugs and hose connections are tight and that there is a sufficient supply of water.	Empty all water into water box. Wash out or flush water jacket if muddy or dirty water has been used.
Belts and ammunition.	Secure sufficient supply of ammunition. Inspect ammunition. Keep belts dry.	Clean, repair, and refill all belts. Separate live rounds from empty cases. Inspect ammunition.
Oil-----	See that the oilcan is full.	Refill oilcan.
Spare parts and tools.	Keep clean and oiled. See that kits are complete.	Check, replace broken or missing parts, clean, and oil.

**145. Lubrication of subcaliber machine gun M1917A1 and mounts T10 and M8.**—*a. Scope.*—These instructions apply only to oils used for lubricating caliber .30 and caliber .50 machine guns. The parts are best oiled by wiping with a slightly oiled cloth.

*b. Lubricating oils.*—(1) For all caliber .30 and caliber .50 AA machine guns, use oil, lubricating, preservative, light, at all temperatures.

(2) For mounts M8 and T10, use oil, engine, in the grades recommended for the 37-mm gun, carriages M3 and M3A1. See lubrication section, paragraph 49.

(3) Oil, engine, shall be applied lightly to all exposed and moving parts weekly, when gun is not being fired, and daily, when being fired. Exposed and moving parts should be wiped clean before lubrication.

(4) At all times when not being fired, mounts M8 and T10 (including the trigger mechanism, brackets and gun), should be protected from the weather by a tarpaulin and inspected daily for signs of rusting.

**146. Organization spare parts and accessories for subcaliber equipment.**—*a. Organization spare parts.*—A separate set of spare parts is supplied to the using arm for each subcaliber gun. After the initial issue, the set will be kept complete by requisitioning new parts to replace those used. Allowances are prescribed in the SNL's for the major equipment.

*b. Accessories.*—The accessories are tools and equipment issued to the using arm for cleaning and preserving the subcaliber gun and mount, and for keeping a complete record of their use.

**147. Belt-loading machine** (fig. 130).—*a. General.*—This machine is for the rapid loading of belts and is intended to be fastened to a table or bench while in use.

*b. To fill feed belt with cartridges.*—(1) Fasten the machine to a table or bench, and turn the crank (10) to the right until it is straight down.

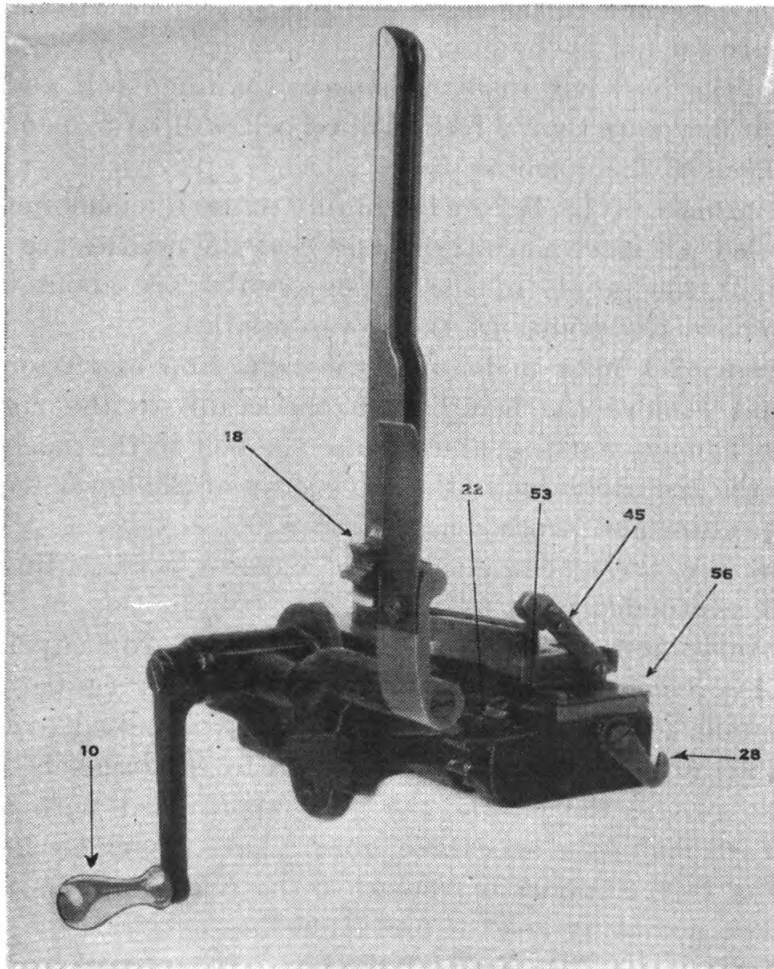


FIGURE 130.—Belt-filling machine.

(2) Release the tension spring hook (28) and raise the upper feed wheel (18) as far as it will go.

(3). Turn the belt guide cover (56) to the right far enough to admit the belt into the belt guide (53) and raise the upper needle bar (45) as far as it will go.

(4) There is a black thread running on the side of the belt which indicates the side for the entrance of the cartridge. Put two cartridges

by hand into the two loops of the belt nearest the end with the brass tip, and place the belt in the machine with the first cartridge resting in the top groove of the lower feed wheel (22), and the belt passing out at the back through the belt guide.

(5) Return the belt guide cover to place over the belt (being careful to see that the belt is free to pass under it), and lower the needle bar.

(6) Turn the upper feed wheel down upon the belt and secure the tension spring under the hook.

(7) Fill the feed guide with cartridges.

(8) Turn the crank to the right and the cartridges will be fed into the belt ready for use in the gun.

(9) Place the feed box ready to receive the filled belt and at such a height that not more than 2 feet of filled belt will be suspended from the feed wheels of the machine.

(c) *Precautions.*—(1) Before beginning to use the machine, see that it is well oiled, all screws are tight, and that the needles are properly set. See that the points of the upper needles are about 0.01 inch vertically above the points of the lower needles.

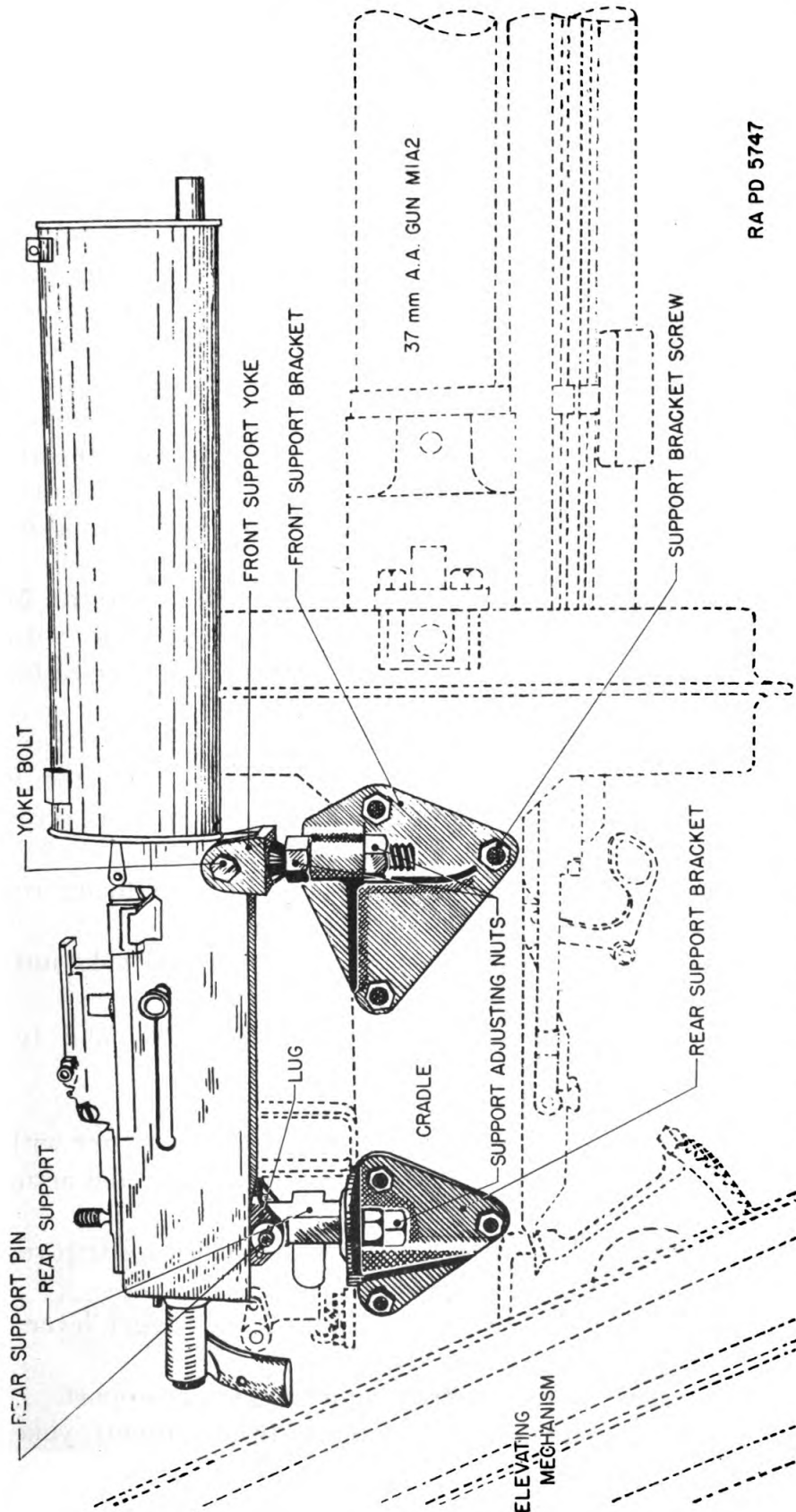
(2) In case of a miss in loading the belt, stop and open up the machine and remove the belt. Turn the crank to the right until straight down, as in starting, and replace the belt in the machine with the next to the last cartridge in the top groove of the lower feed wheel. Close the machine and proceed as before.

(3) After use, the machine should be cleaned, oiled, adjusted, and replaced in its wooden box.

**148. Description of subcaliber mount M8 for carriage M3** (fig. 131).—*a. General.*—Subcaliber mount M8 for caliber .30 subcaliber machine gun M1917A1 on carriage M3 is bolted to the right side of the 37-mm gun cradle. In addition to the brackets and bolts holding the gun to the cradle, the gun is provided with a trigger mechanism for firing the subcaliber gun. The trigger mechanism on the actuating lever support is secured to the rear support of the gun mount by two actuating lever support screws.

*b. Front support.*—The front of the gun is supported by the front support yoke resting in a triangular-shaped bracket, bolted to the right side of the 37-mm gun cradle. A U-shaped yoke supports the front part of the gun (mechanism) and is secured with a pin, locked by a cotter pin. The lower threaded portion of the yoke is secured in the front support bracket by adjusting nuts. To give small changes in range, the adjusting nuts raise or lower the front end of the gun by tightening or loosening them as the case may be and by drawing them tight against the bracket slot.





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FIGURE 131.—Gun support, caliber .30 subcaliber mount M8, carriage M3.

*c. Rear support.*—The rear support of the gun consists of a T-shaped, rectangular block having a projection toward the center of the carriage. The lower threaded portion of the support slides horizontally (in azimuth) in a slot in the rear bracket. The rear end of the gun pivots vertically for change in range.

**149. Operation of trigger firing mechanism, subcaliber mount M8 (fig. 132).**—Depression of the foot pedal on the foot-firing mechanism of the carriage moves the foot-firing cam, pushing the firing rod upward. The longer arm of the actuating lever moves upward, rotating on the actuating lever pin. The shorter arm of the actuating lever lifts the trigger rod. The trip rod passes through a hole in the pin of the trigger lever, held in place by the upper and lower trip rod springs. When the trip rod lever moves upward, the trigger lever also moves upward. The trigger lever trips the trigger of the gun. The gun will continue to fire as long as the pedal is held down and ammunition supplied.

**150. Disassembly and assembly of subcaliber mount M8.**—

*a. Removing gun from mount.*—(1) Supporting the gun with the hand, remove yoke bolt. Drive out rear support pin after cotter pin has been removed.

(2) Lift gun out of supports and set in level place.

*b. Disassembly of subcaliber mount.*—(1) Supporting the firing mechanism with the hands, remove actuating lever support screws.

(2) Remove the assembly.

*c. Disassembly of firing mechanism.*—(1) Remove firing rod by driving out the pin which supports the rod in the yoke.

(2) Remove firing rod yoke by loosening firing rod yoke nut.

(3) Unscrew firing rod yoke.

(4) Remove cotter pin holding trip rod castle nut and remove nut and the lower trip rod spring and washer.

(5) Remove pin securing trip rod to yoke.

(6) Holding trip rod collar, upper spring, and washers with the hand, slip trip rod from trip rod lever, trip rod collar, and actuating lever support.

(7) Remove trip rod yoke from trip rod by removing trip rod adjusting nut. Unscrew trip rod yoke.

(8) Slip trip rod lever and trigger lever from trigger lever shaft after taper pins have been taken out.

(9) Drive trigger lever shaft from actuating lever support.

*d. Disassembly of mount.*—(1) Remove front support yoke and rear support by removing support adjusting nuts.

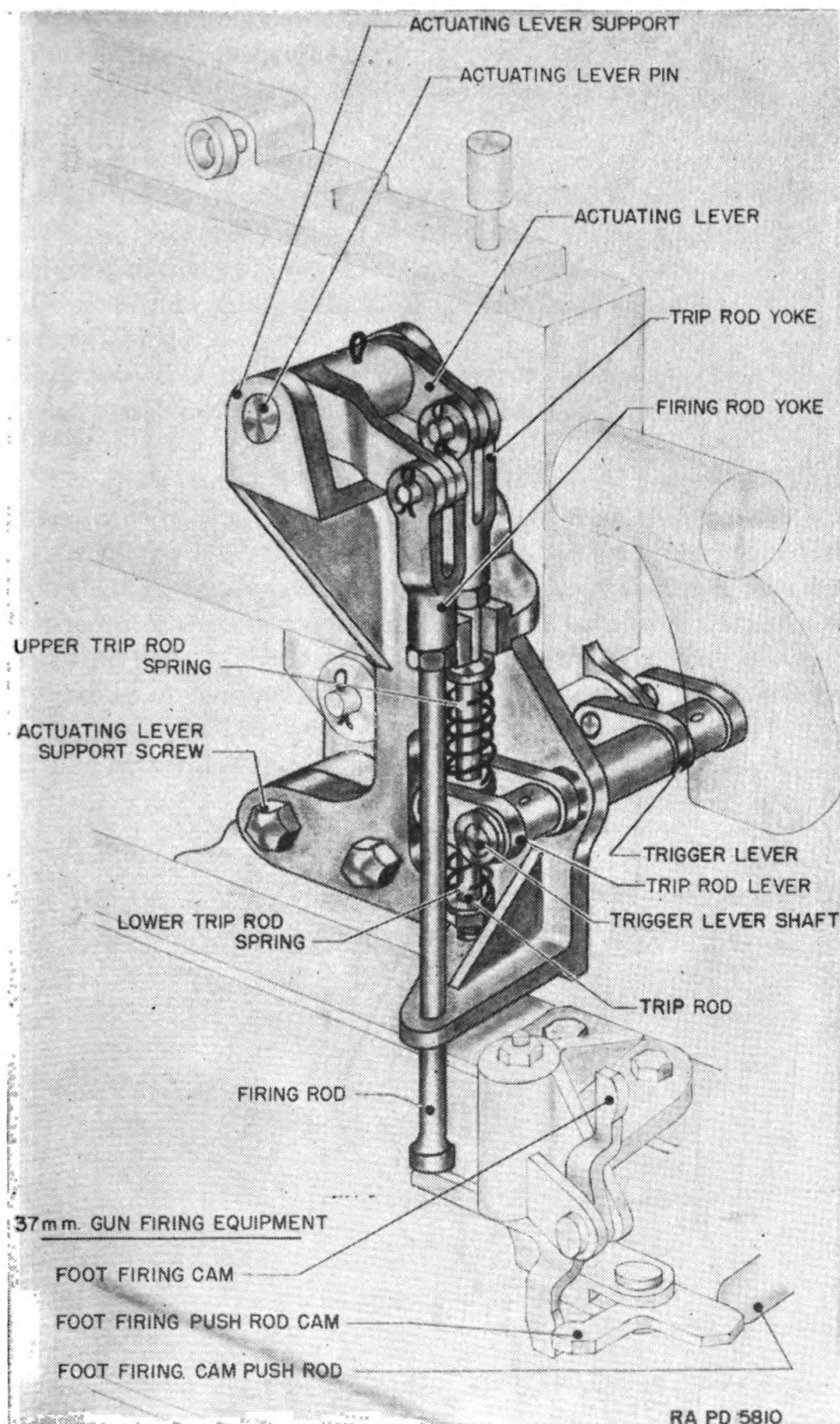
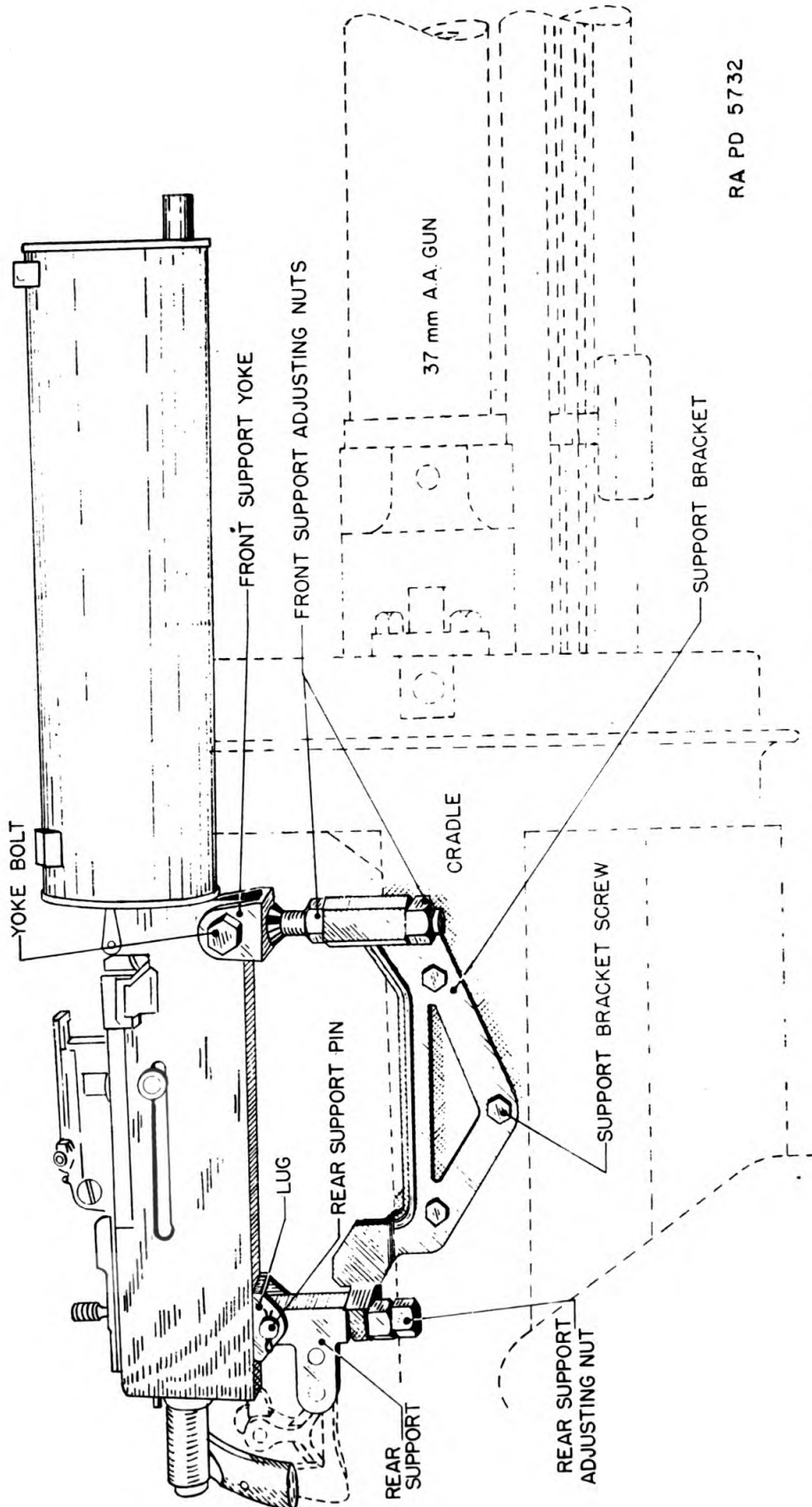


FIGURE 132.—Subcaliber firing mechanism, mount M8, carriage M3.



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FIGURE 133.—Gun support, caliber .30, subcaliber mount T10, carriage M3A1.

(2) Unscrew support bracket screws and remove front and rear support brackets from cradle.

(3) Remove ammunition box support by unscrewing ammunition chest support screws.

*e. Assembly.*—Reverse the operations described above.

**151. Description of subcaliber mount T10 for carriage M3A1 (fig. 134).**—*a. General.*—The subcaliber mount T10, for the caliber .30 subcaliber machine gun, on the M3A1 carriage is bolted to the right side of the 37-mm gun cradle. At present this subcaliber mount is under development.

*b. Support.*—The design of the bracket of this gun is triangular, of one piece, instead of two sections, as in the case of mount M8 on the M3 carriage.

(1) The front end of the gun rests in a U-shaped yoke welded to the top of a threaded bolt. Together they comprise the front support yoke. This yoke is pivoted to the gun by a bolt or pinion which slips through the lugs on the gun and the bracket and is secured by a cotter pin. The lower threaded portion of the yoke is secured to the bracket by adjusting nuts. These can raise or lower the front end of the gun by tightening or loosening them, as the case may be. The nuts also lock the yoke in the bracket.

(2) The rear of the gun is supported by the rear support.



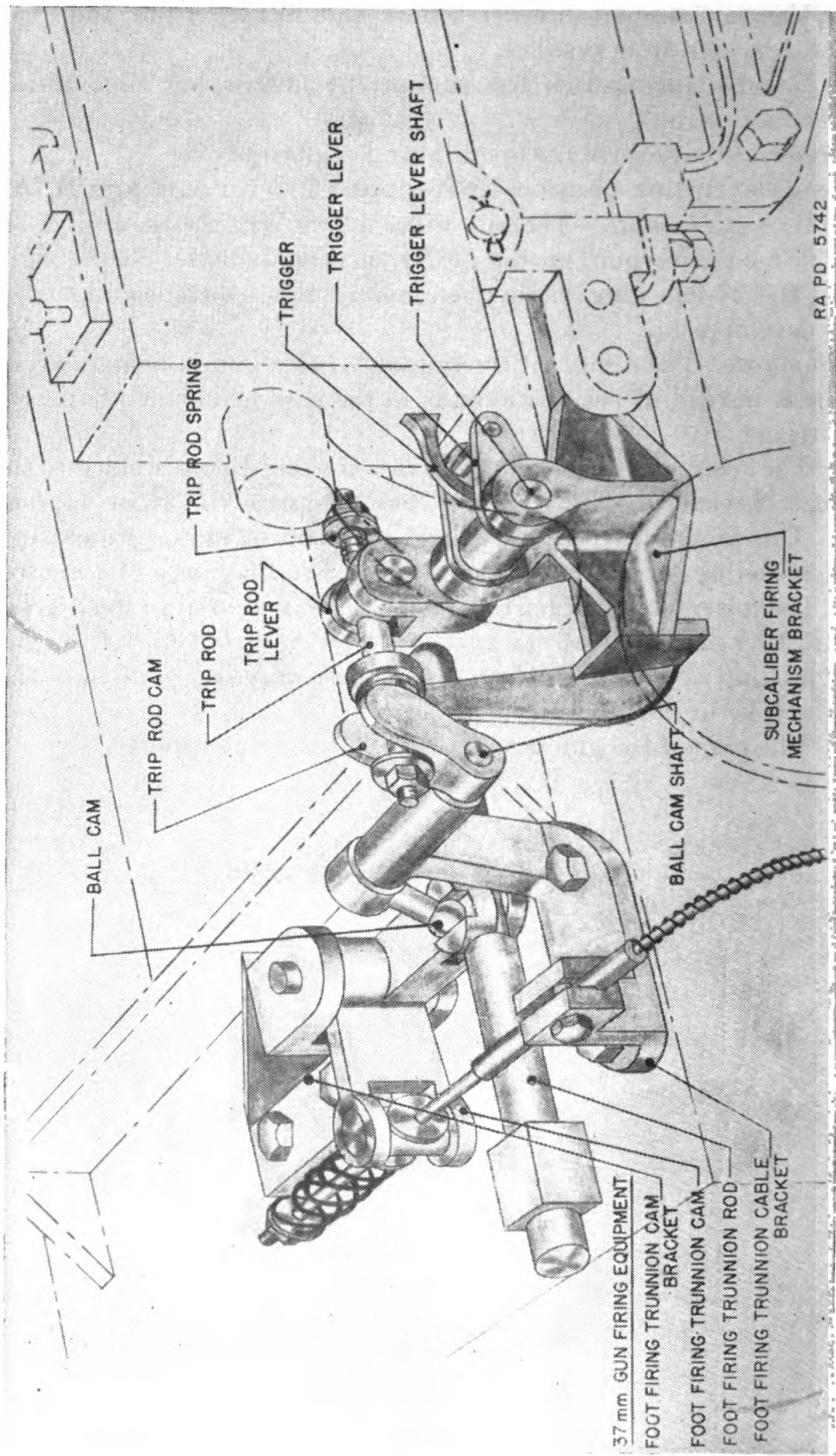


FIGURE 134.—Subcaliber firing mechanism, mount T10, carriage M3A1.

**152. Operation of trigger firing mechanism, mount T10.—**

The caliber .30 subcaliber machine gun M1917A1 on the M3A1 carriage is fired by the foot pedal used to fire the 37-mm gun. A flexible shaft carries this motion from the foot pedal. The foot-firing trunnion rod moves forward by the motion against it of the foot-firing trunnion rod cam. The foot-firing trunnion rod pushes the ball cam forward. The motion of the ball cam, secured to ball cam shaft by a taper pin, rotates the ball cam shaft in the foot-firing trunnion cable bracket. The rotation of the ball cam shaft moves the trip rod cam backwards. The trip rod cam forces the trip rod backward by pressure against a nut and washer on the trip rod. Sliding in the bearing of the firing mechanism bracket, the trip rod pulls rearward on the trip rod lever held on the trip rod by a spring, washer, and nut. As the trip rod lever moves rearward, the trigger lever is moved up against the trigger.

**153. Disassembly and assembly of subcaliber mount T10.—**

*a. Removing gun from mount.*—(1) While supporting the gun, remove yoke bolt.

(2) Drive out rear support pin, after removing cotter pin.

(3) Lift gun out of supports and set in a level place.

*b. Removal of firing mechanism and bracket.*—(1) Remove firing mechanism bracket by removing its screws and washers which secure bracket to rear support.

(2) Slip firing mechanism down and out from under trigger of subcaliber gun; lift rear end of trip rod out of ball cam.

*c. Disassembly of firing mechanism.*—(1) Drive out taper pin from ball cam and slide ball cam off ball cam shaft.

(2) Drive out taper pin from trip rod cam.

(3) Slip trip rod cam from ball cam shaft.

(4) Remove nuts, washers, and trip rod spring from ends of trip rod. Pull trip rod rearward and out of firing mechanism bracket.

(5) Drive ball cam shaft from foot-firing trunnion cable bracket (37-mm foot firing mechanism) on cradle.

(6) Tap out taper pin from trip rod lever.

(7) Slide trip rod lever from trigger lever shaft.

(8) Tap trip rod lever pin out of trip rod lever.

(9) Tap out taper pin from trigger lever.

(10) Remove trigger lever shaft.

*d. Disassembly of gun mount.*—(1) Remove rear support by removing rear support adjusting nuts and washers.

(2) Remove front support yoke by removing lower adjusting nut and lifting yoke out of support bracket.

(3) Remove support bracket by removing support bracket screws and washers.

(4) Remove ammunition support bracket for holding ammunition box by removing ammunition box support bracket screws.

*e. Assembly.*—Reverse the above operation.

**154. Ammunition box and feeding equipment for subcaliber mounts M8 and T10.**—*a.* The ammunition box used is the caliber .30 wooden ammunition box M1917 and has a projecting bracket which fits into the ammunition box support (fig. 135).

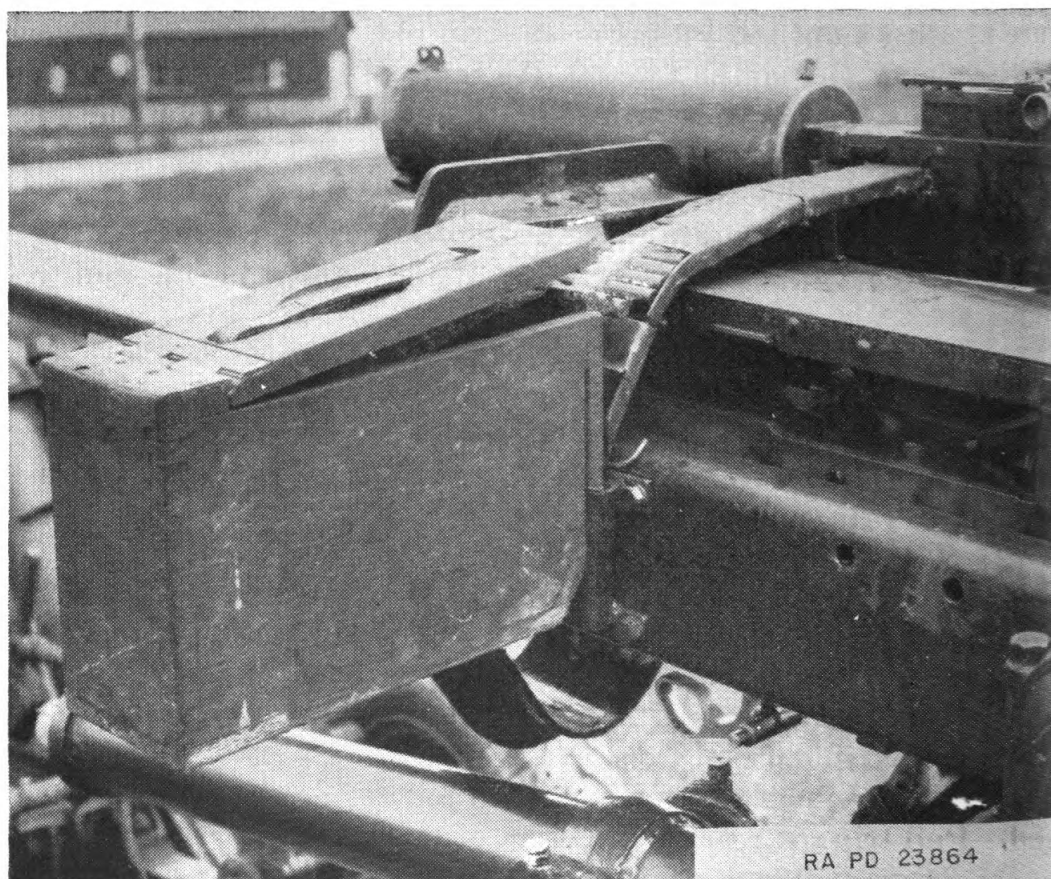


FIGURE 135.—37-mm subcaliber ammunition box, feeding equipment, and tray, carriages M3 and M3A1.

*b.* An ammunition tray will be supplied, made of sheet metal and brazed together. This tray is necessary to carry the cartridges over the top of 37-mm gun mechanism. The design and arrangement can be seen from figure 135.

(1) The ammunition tray is used to aline the ammunition with the receiver of the gun or the ammunition will jam. The tray must be deep enough not to cause undue drag or friction.

(2) Since the attachment of the caliber .30 ammunition tray interferes with the firing of the 37-mm gun, the caliber .30 gun cannot be fired at the same time as the 37-mm gun.

(3) In order that the ammunition may be fed correctly, the cover of the ammunition box should be as nearly closed as possible so as to push downward on the cartridges as they emerge from the box.

## SECTION XIV

### ORGANIZATION SPARE PARTS AND ACCESSORIES

	Paragraph
Organization spare parts.....	155
Accessories .....	156
Accessories for cal. .50 machine gun.....	157

**155. Organization spare parts.**—*a.* A set of organization spare parts is supplied to the using arm for field replacement of those parts most likely to become broken, worn, or otherwise unserviceable. The set is kept complete by requisitioning new parts for those used. Organization spare parts are listed in pertinent Standard Nomenclature Lists.

*b.* Care of organization spare parts is covered in section VI.

**156. Accessories.**—*a.* Accessories include tools and equipment required for such disassembling and assembling as the using arm is authorized to perform, and for the cleaning and preservation of the gun carriage, sighting and fire-control equipment, ammunition, etc. They also include chests, covers, tool rolls, and other items necessary to protect the matériel when it is not in use, or when traveling. Accessories should not be used for purposes other than as prescribed, and when not in use should be properly stored.

*b.* There are a number of accessories whose names or general characteristics indicate their use. Others, embodying special features or having special uses, are described below:

(1) *Firing lanyard adapter* (fig. 136).—This adapter is inserted over the trigger connector bracket lever of the 37-mm gun for firing the gun at a safe distance. A thumbscrew is provided for securing the adapter to the lever. The foot-firing mechanism lever which actuates the trigger connector bracket lever will have to be removed for installation of the firing lanyard adapter.

(2) *Ammeter* (for electric brakes).—This ammeter is used for measuring the current taken by the electric brakes of the carriage. It is used by connecting one terminal of the meter to one wire and the other terminal of the meter to the point to which the wire normally

is attached. When the current is supplied to the brakes this meter registers the current flowing through the brakes.

(3) *37-mm bore brush M8 and cleaning staff M5A2* (fig. 137).—The brush is screwed to the staff for cleaning the gun tube.

(4) *Priming rod*.—The priming rod is a long hooked rod which is used to retract the lock frame from a short distance behind the gun.

(5) *Tube support* (fig. 139).—The tube support is used to support the gun tube when removing it from the gun (see par. 64 for method of handling the tube support).

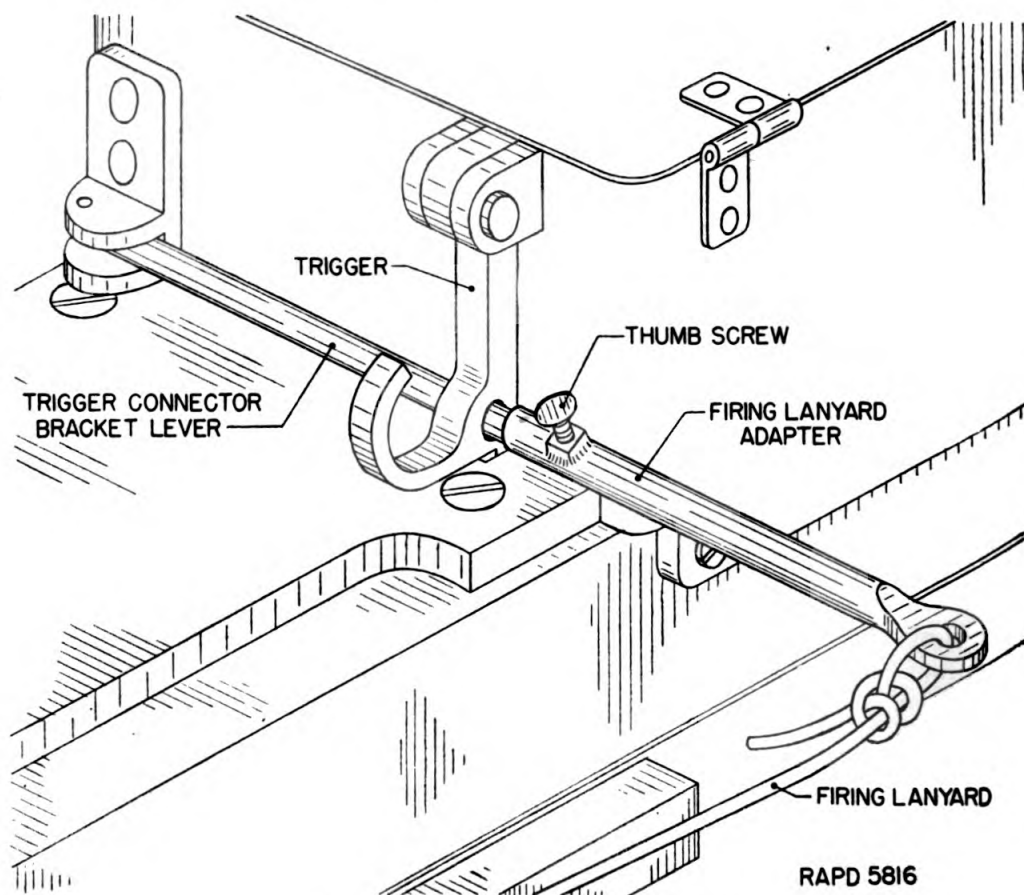


FIGURE 136.—Firing lanyard adapter.

(6) *Counterpoise and equilibrator cylinder wrenches* (fig. 138).—These two sets of wrenches are used to turn the adjusting nuts of the counterpoise and equilibrator mechanisms. The section on adjustment describes their use.

(7) *Tube wrench*.—The tube wrench is used initially to loosen the gun tube when unscrewing it from the gun (see par. 64).

**157. Accessories for cal. .50 machine gun.**—*a. Brush, cleaning, caliber .50, M4.*—The brush consists of the core, bristles, and tip.



The brass wire core is twisted in a spiral and holds the bronze bristles in place. The core is secured in the brass tip which is threaded for attaching the brush to the cleaning rod.

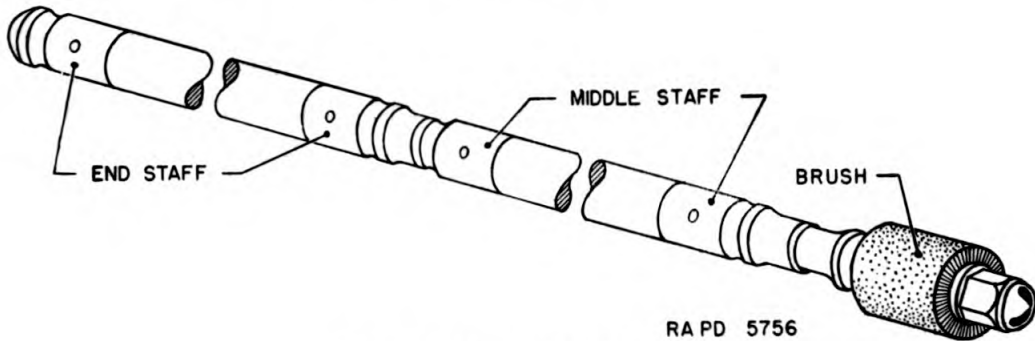


FIGURE 137.—Staff and brush.

*b. Case, cleaning rod, M1.*—The case is a fabric container with five pockets, four of which hold the sections of the jointed cleaning rod M1, while the fifth holds the cleaning brush, caliber .50, M4. The contents are secured in their pockets by a web billet and chape with buckle.

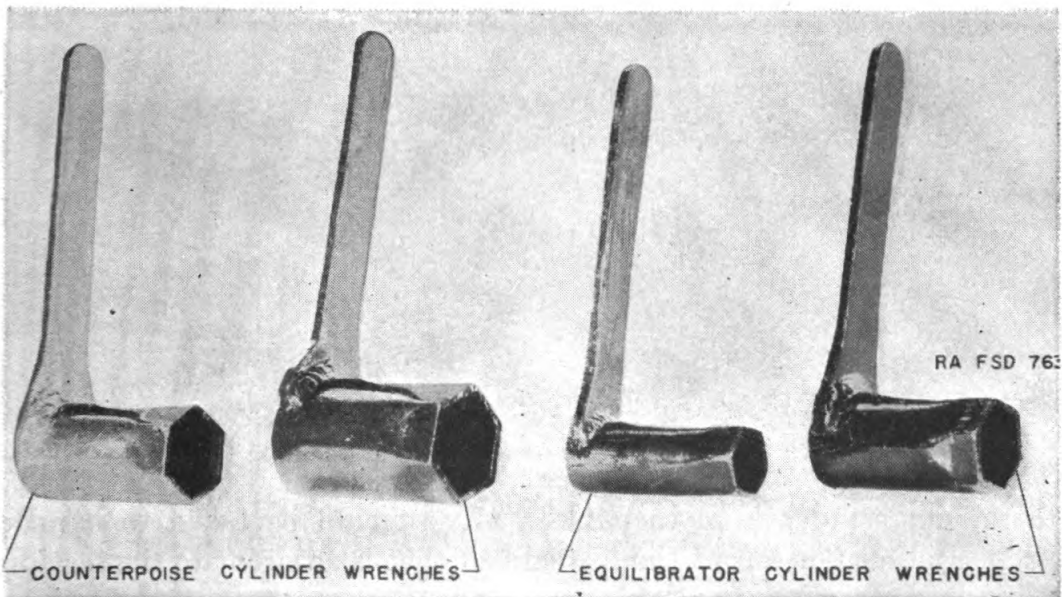


FIGURE 138.—Counterpoise and equilibrator cylinder wrenches.

*c. Cup, filling.*—The filling cup is used for filling the machine-gun water jacket. It consists of a conical shaped leather body having a small brass nozzle riveted to the bottom surface.

*d. Gage, head space and timing.*—Used for checking the head space adjustment as described in paragraph 63. The timing element of this gage is not necessary for the antiaircraft installation.

*e. Machine, link loading, caliber .50, M2.*—The link loading machine (fig. 140) is used for rapid loading of ammunition into metallic links. It may be screwed to a bench, ammunition box, or other suitable support when in use, screw holes being provided in its base for this purpose. Links, properly assembled, are placed on the loading bed adjacent to the U-shaped stops, and cartridges are placed in the grooves provided. The loading is performed by the operation of the loading handle which, when pushed forward to the stop, will load the cartridges

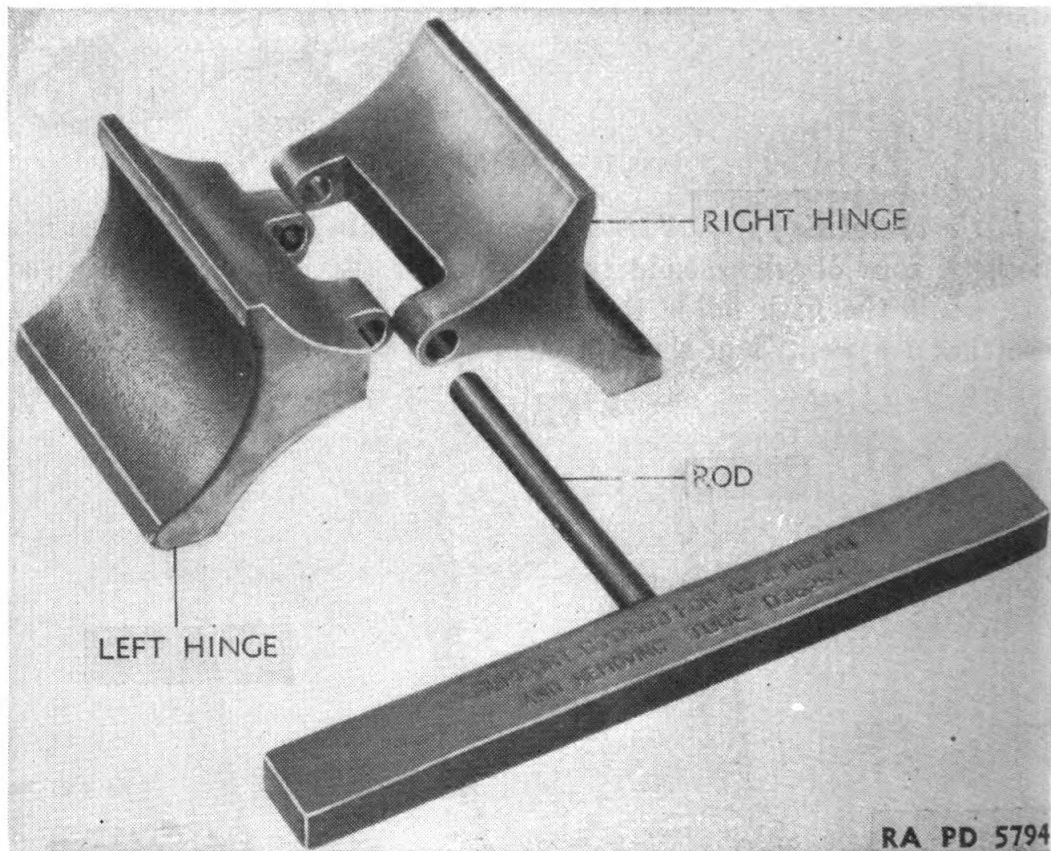


FIGURE 139.—Tube support.

to the correct depth in the links. Care should be taken to handle properly that portion of the loaded belt that is adjacent to the section being loaded.

*f. Oiler, filling, oil buffer.*—This oiler consists of  $\frac{1}{2}$ -pint capacity oilcan with a nozzle 5 inches long. It is used only for filling the oil buffer.

*g. Rod, cleaning, jointed.*—This is a steel rod of five sections, the first two of which are permanently fastened together. The rear section is provided with a tubular steel handle which swivels on the rod.

The first section has a slot formed for holding a cleaning patch and a threaded hole for attaching the cleaning brush.

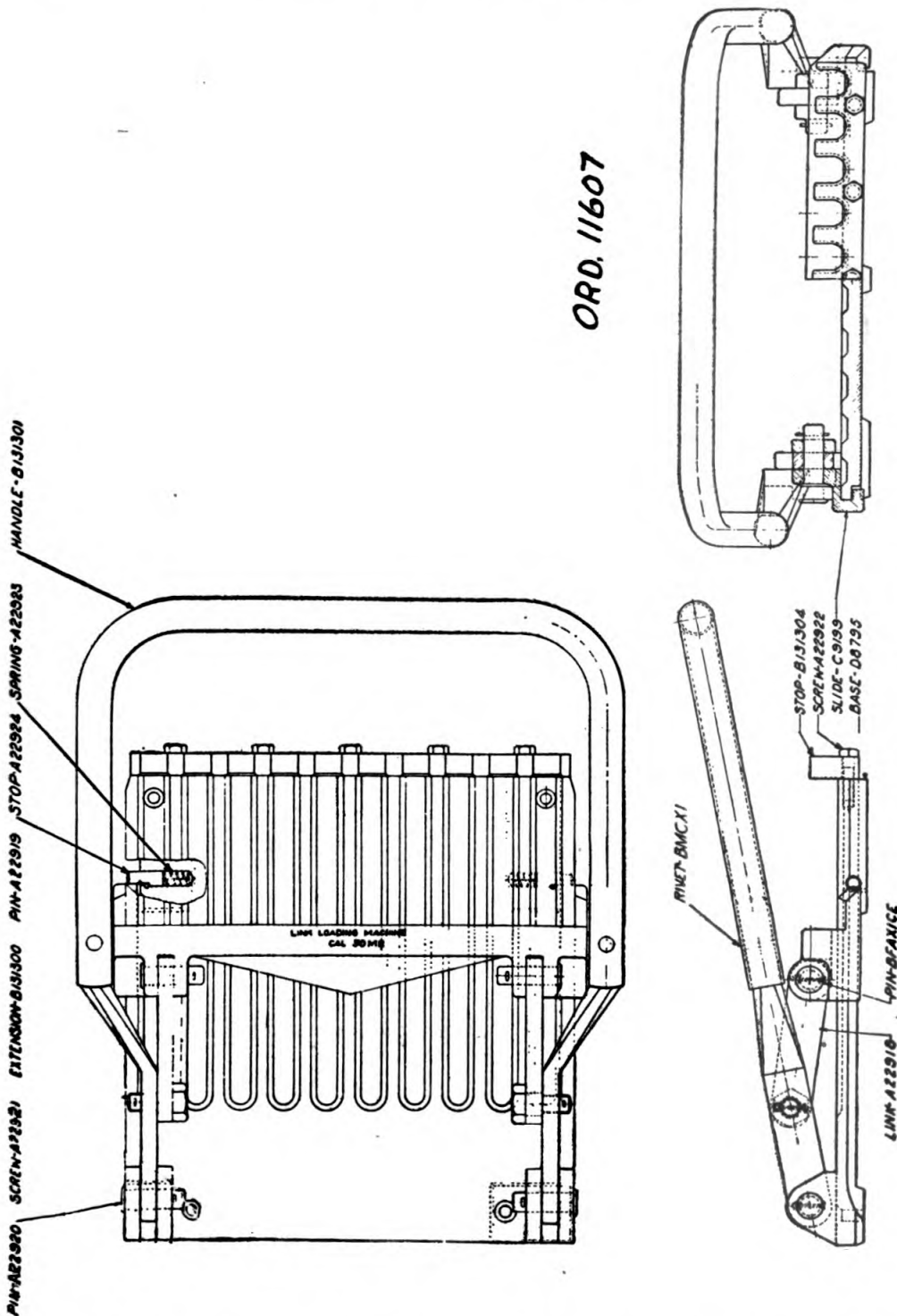


FIGURE 140.—Machine, link loading, caliber .50, M2.

*h. Rod, cleaning.*—This rod consists of two sections permanently fastened together. The rear section is provided with a tubular steel

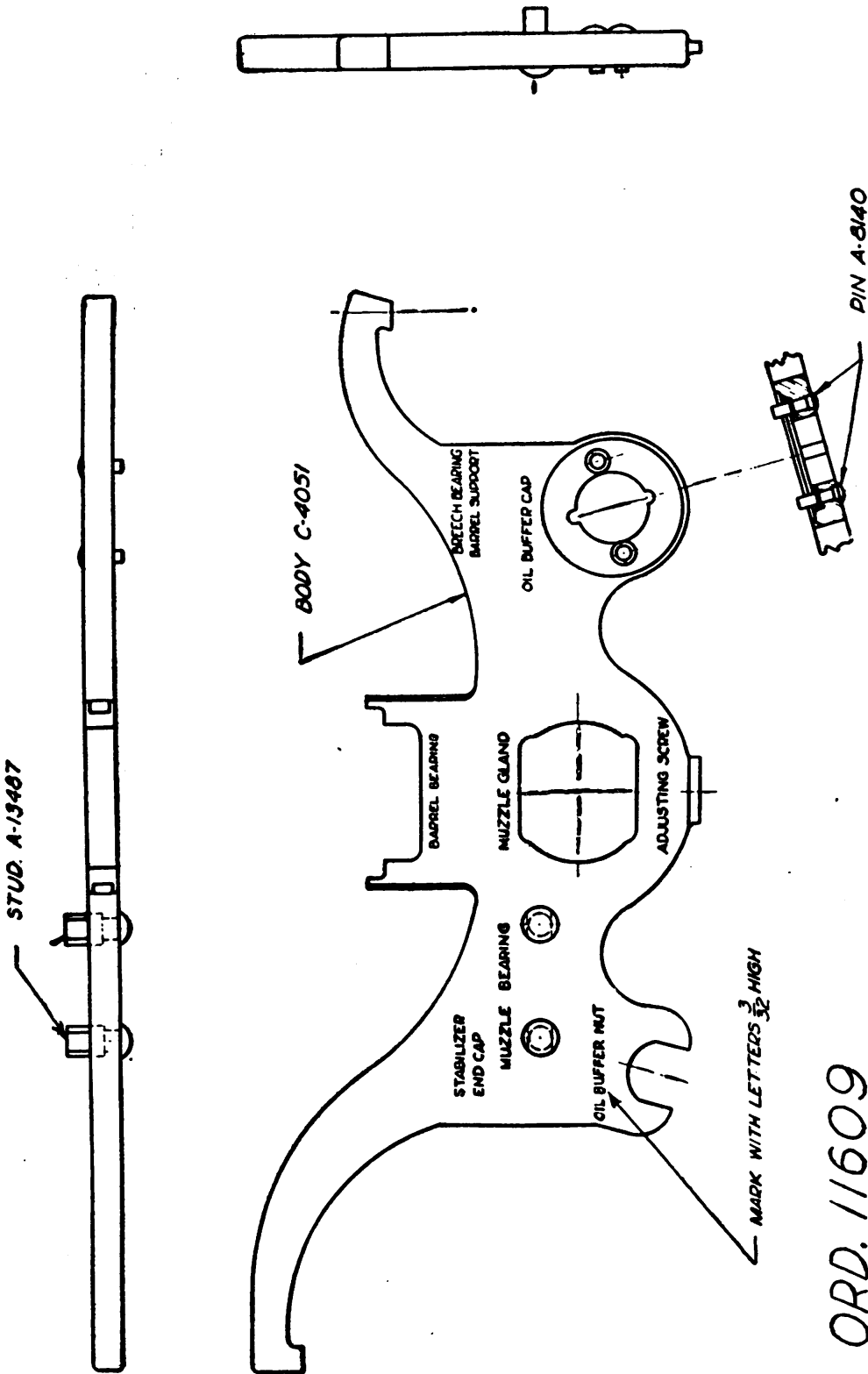


FIGURE 141.—Wrench, combination, M2.

handle which swivels on the rod. The front section has a threaded hole for attaching the cleaning brush and a slot for holding a cleaning patch.

*i. Wrench, adjusting packing ring.*—This wrench which is used to turn the packing adjusting ring when adjusting the packing on the rear of the barrel is a single and spanner having its handle bent at an angle. At the end of the arc of the spanner a cylindrical lug is formed. When in use, this lug engages in one of the several holes formed in the packing adjusting ring.

*j. Wrench, combination, M2* (fig. 141).—This is a special tool for disassembling, assembling, and making adjustments of the gun. Each opening and projection is marked to show its purpose.

*k. Wrench, barrel holding.*—This wrench is used to hold the barrel when using the packing ring adjusting wrench. It is made of flat steel,  $\frac{1}{8}$  inch thick,  $\frac{7}{16}$  inch wide, and 3 inches long. One end is shaped to adapt it to the serrations and general contour of the barrel.

## SECTION XV

### STORAGE AND SHIPMENT

	Paragraph
Storage.....	158
Shipment by rail.....	159
Shipment by water.....	160

**158. Storage.**—*a. General.*—The 37-mm antiaircraft gun matériel may be stored either with the gun mounted or with the gun dismounted, since dismounting the gun does not conserve space. All precautions should be taken to prevent corrosion, to keep recoil mechanism exercised, and to prevent deterioration of rubber. The carriage will be completely lubricated before storage and rust-proofed as directed in *b* and *c* below.

*b. Preservation.*—(1) *General instructions.*—All unpainted surfaces must be protected from corrosion by the application of a corrosion preventive. All such surfaces must be made free of films of moisture, dirt, and other foreign substances. This is accomplished by cleaning the surfaces with a solvent, such as solvent, dry-cleaning, Federal Specification P-S-661, or with soap solution. After a soap solution is used the surfaces must be rinsed with clean hot water. Before application of corrosion preventive the surface must be thoroughly dried. The corrosion preventive shall be applied immediately after cleaning and drying the surfaces.

(2) *Interior surfaces.*—Interior surfaces from which it would be difficult to remove corrosion preventives, such as the bore of the gun



and moving parts in the breech mechanism, will have applied a film of compound, rust-preventive, light, U. S. Army Specification 2-84. This film will be applied by brushing and slushing the surface until a film completely covers the surface.

(3) *Exterior surfaces.*—Exterior surfaces will be treated with compound, rust-preventive, thin film, Specification AXS-673. This preventive will be applied by spraying or brushing and will harden to a tough thin film.

*c. Sealing of gun barrel.*—After the above operations are complete a piece of canvas or burlap should be impregnated with compound, rust-preventive, thin film, Specification AXS-673, or heavy grease and placed over the muzzle of the gun and firmly tied or strapped in place.

*d. Rubber preservation.*—The carriage should be either jacked off the floor by means of blocks or the weight removed from the tires by dropping the carriage and lifting the wheels. The pressure in the tires should be reduced 5 pounds after the weight of the carriage is removed from tires. When carriages are stored in open storage, the tires should be coated with a synthetic rubber paint as a protective covering. This protection can also be obtained by covering the tires with canvas or a similar material.

*e. General inspection.*—Before storing the gun and carriage, they will be completely inspected and all broken and damaged parts repaired or replaced.

*f. Depreservation.*—When the gun and carriage is removed from storage all corrosion preventive must be removed and the parts lubricated or protected by the use of a lubricant. This depreservation is accomplished by the use of a solvent, such as solvent, dry-cleaning, Federal Specification P-S-661, after which all surfaces are protected and lubricated with a film of lubricating oil.

**159. Shipment by rail.**—*a. Preparation.*—The gun and carriage will be cleaned and preserved for shipment by rail as directed in paragraph 158*b*. The muzzle cover will be in place and the gun and carriage will be inspected and all damaged or missing parts repaired, replaced, or reported.

*b. Loading carriage.*—The carriage will be loaded from permanent ramps when available but improvised ramps may be built of railroad ties or other available lumber when necessary. After the carriage is in place on the railroad car the brakes will be set.

*c. Minimum requirements for blocking 37-mm antiaircraft gun matériel.*—(1) *Brake wheel clearance.*—There will be a 6-inch clearance in back, on both sides of, and above the brake wheel. Brake wheel

clearance should be increased as much as is consistent with proper location of load. (See fig. 142 (A).)

(2) *Blocks*.—Eight blocks are required to restrain the gun and mount from any longitudinal movement while in transit. The blocks will be 6" x 24" as illustrated by pattern 3, figure 142. One block will be placed in front and one block to the rear of each wheel supporting the carriage. The height of each block at point of contact with the tire will be not less than 4 inches from the car floor. The heel of the block will be nailed to the car floor with three 40-penny nails and that portion under the tire toe-nailed to car floor with two 40-penny nails before the cleats are applied. (See fig. 142.)

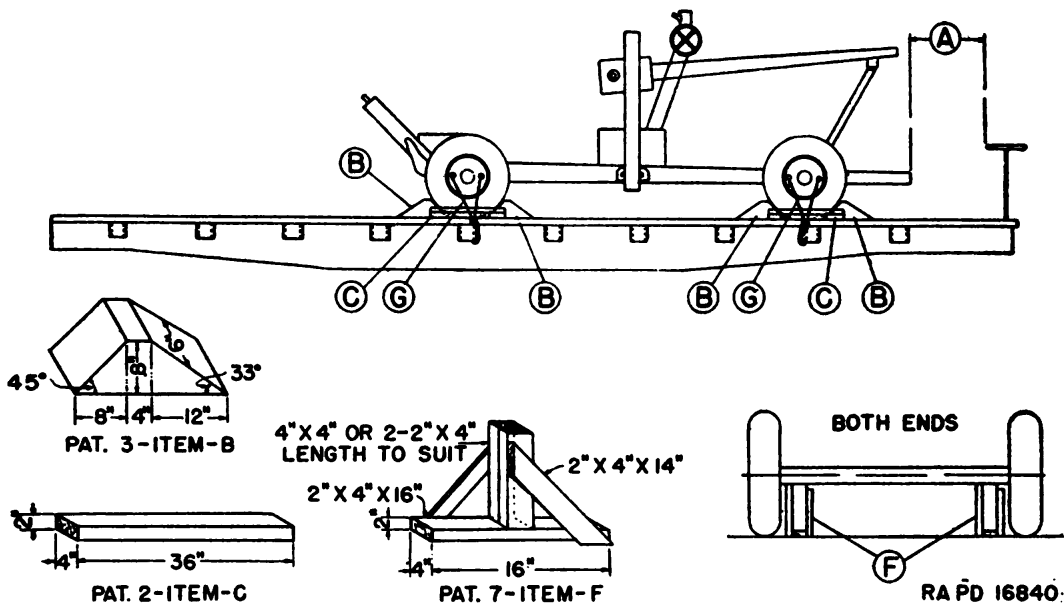


FIGURE 142.—Method of blocking 37-mm AA gun matériel.

(3) *Cleats*.—Eight cleats are required in order to prevent any skidding or side slipping movement of the carriage while in transit. Cleats will be cut 2" x 4" x 36" as illustrated in pattern 2, figure 142.

(4) *Braces*.—Braces will be constructed and placed under both front and rear axles, partially relieving the weight on the tires, thus preventing any bouncing or galloping of the mount while in transit. The braces will be constructed as illustrated in pattern 7, figure 142. The height of the braces will be the distance between the axle and car floor plus one-quarter inch. The braces will be placed between car floor and axle. (See fig. 142 (F).)

(5) *Flat steel or wire strapping*.—Flat steel strapping or No. 8 Gage black annealed wire will be used to tie the carriage down, pre-

venting overriding of the blocks. Four strands, two wrappings of No. 8 Gage black annealed wire will be passed through holes in wheels and secured to the stake pockets of a flat car and twist tied with rod or bolt. When the carriage is shipped in a box car either flat steel or wire strapping may be used. The strapping will pass over the axle over each brace (fig. 142(F)) and will terminate securely under wood blocks which are nailed to the car floor.

*d. Depreservation.*—When the gun and carriage reach their destination, they will be depreserved as directed in paragraph 158*f*.

**160. Shipment by water.**—*a. Preparation.*—The gun and carriage will be prepared as directed in paragraphs 158*b*, *c*, and *e* and will be depreserved as directed in paragraph 158*f*.

*b. Crating.*—In order to protect the gun and carriage and to conserve space, the gun and carriage will be crated or boxed for water shipment unless shipped on deck and used on deck as an antiaircraft weapon. Crating or boxing will be performed in accordance with Introduction to Ordnance Storage and Shipment Charts, section (a), "Instructions and Specifications for Packaging Ordnance General Supplies."

## SECTION XVI

### PAINTING

	Paragraph
General .....	161
Preparing for painting .....	162
Painting metal surfaces .....	163
Paint as a camouflage .....	164
Removing paint .....	165
Painting lubricating devices .....	166

**161. General.**—*a.* Ordnance matériel is painted before issue to the using arms and one maintenance coat per year will ordinarily be ample for protection. With but few exceptions this matériel will be painted with enamel, synthetic, olive-drab, lusterless. The enamel may be applied over old coats of long oil enamel and oil paint previously issued by the Ordnance Department if the old coat is in satisfactory condition for repainting.

*b.* Paints and enamels are usually issued ready for use and are applied by brush or spray. They may be brushed on satisfactorily when used unthinned in the original package consistency or when thinned no more than 5 percent by volume with thinner. The enamel will spray satisfactorily when thinned with 15 percent by volume of thinner. (Linseed oil must not be used as a thinner since it will impart a luster

not desired in this enamel.) If sprayed, it dries hard enough for repainting within  $\frac{1}{2}$  hour and dries hard in 16 hours.

*c.* Certain exceptions to the regulations concerning painting exist. Fire-control instruments, sighting equipment, and other associated items will not be painted.

*d.* Complete information on painting is contained in TM 9-850.

**162. Preparing for painting.**—*a.* If the base coat on the matériel is in poor condition, it is more desirable to strip the old paint from the surface than to use sanding and touchup methods. After stripping, it will then be necessary to apply a primer coat.

*b.* Primer, ground, synthetic, should be used on wood as a base coat for synthetic enamel. It may be applied either by brushing or spraying. It will brush satisfactorily as received or after the addition of not more than 5 percent by volume of thinner. It will be dry enough to touch in 30 minutes, and hard in 5 to 7 hours. For spraying, it may be thinned with not more than 15 percent by volume of thinner. Lacquers must not be applied to the primer, ground, synthetic, within less than 48 hours.

*c.* Primer, synthetic, rust inhibiting, for bare metal, should be used on metal as a base coat. Its use and application is similar to that outlined in *b* above.

*d.* The success of a job of painting depends partly on the selection of a suitable paint, but also largely upon the care used in preparing the surface prior to painting. All parts to be painted should be free from rust, dirt, grease, kerosene, oil, and alkali, and must be dry.

**163. Painting metal surfaces.**—If metal parts are in need of cleaning, they should be washed in a liquid solution consisting of  $\frac{1}{2}$  pound of soda ash in 8 quarts of warm water, or an equivalent solution, then rinsed in clear water and wiped thoroughly dry. Wood parts in need of cleaning should be treated in the same manner, but the alkaline solution must not be left on for more than a few minutes and the surfaces should be wiped dry as soon as they are washed clean. When gun matériel is in fair condition and only marred in spots, the bad places should be touched with enamel, synthetic, olive-drab, lusterless, and permitted to dry. The whole surface will then be sandpapered with paper, flint, No. 1, and a finish coat of enamel, synthetic, olive-drab, lusterless, applied and allowed to dry thoroughly before the matériel is used. If the equipment is in bad condition, all parts should be thoroughly sanded with paper, flint, No. 2, or equivalent, given a coat of primer, ground, synthetic, and permitted to dry for at least 16 hours. They will then be sandpapered with paper, flint, No. 00, wiped free from dust and dirt, and a final coat of enamel, synthetic, olive-

drab, lusterless, applied and allowed to dry thoroughly before the matériel is used.

**164. Paint as a camouflage.**—Camouflage is now a major consideration in painting ordnance vehicles, with rust prevention secondary. The camouflage plan at present employed utilizes three factors: Color, gloss, and stenciling.

*a. Color.*—Matériel is painted with enamel, synthetic, olive drab, lusterless, which was chosen to blend in reasonably well with the average landscape.

*b. Gloss.*—The new lusterless enamel makes a gun and carriage difficult to see from the air or from relatively great distances over land. A gun and carriage painted with ordinary glossy paint can be detected more easily and at greater distances.

*c. Stenciling.*—White stencil numbers on guns and carriages have been eliminated because they can be photographed from the air. A blue drab stencil enamel is now used which cannot be so photographed. It is illegible to the eye at distances exceeding 75 feet.

*d. Preserving camouflage.*—(1) Continued friction or rubbing must be avoided, as it will smooth the surface and produce a gloss. The gun and carriage should not be washed more than once a week. Care should be taken to see that the washing is done entirely with a sponge or a soft rag. The surface should never be polished, rubbed, or wiped, except while wet, or a gloss will develop.

(2) It is not desirable that gun and carriages, painted with lusterless enamel, be kept as clean as matériel has been kept when glossy paint was used. A small amount of dust and dirt increases the camouflage value. Grease spots should be removed with solvent, dry-cleaning. Whatever portion of the spot cannot be so removed should be allowed to remain.

(3) Continued friction of wax-treated tarpaulins on the sides of a vehicle will also produce a gloss, which should be removed with solvent, dry-cleaning.

(4) Tests indicate that repainting with olive-drab paint will be necessary once yearly, with blue-drab paint twice yearly.

**165. Removing paint.**—After repeated paintings, the paint may become so thick as to crack and scale off in places, presenting an unsightly appearance. If such is the case, remove the old paint by use of a lime-and-lye solution for metal (see TM 9-850 for details) or remover, paint and varnish, for wood. It is important that every trace of lye or other paint remover is completely rinsed off and that the equipment be perfectly dry before repainting is attempted. It is preferable that the use of lye solutions is limited to iron or steel parts.



If used on wood, the lye solution must not be allowed to remain on the surface for more than a minute before being thoroughly rinsed off and the surface wiped dry with rags. Crevices or cracks in wood should be filled with putty and the wood sandpapered before refinishing. The surfaces thus prepared should be painted according to directions given above.

**166. Painting lubricating devices.**—Oil cups, grease fittings, oil holes, and similar lubricating devices, as well as a circle about three-fourths of an inch in diameter at each point of lubrication, will be painted with enamel, red, water-resisting, in order that they may be readily located.

## SECTION XVII

### MATÉRIEL AFFECTED BY GAS

	Paragraph
Protective measures-----	167
Cleaning-----	168
Decontamination -----	169

**167. Protective measures.**—*a.* When matériel is in constant danger of gas attack, unpainted metal parts will be lightly coated with engine oil. Instruments are included among the items to be protected by oil from chemical clouds or chemical shells, but ammunition is excluded. Care will be taken that the oil does not touch the optical parts of instruments or leather or canvas fittings. Matériel not in use will be protected with covers as far as possible. Ammunition will be kept in sealed containers.

*b.* Ordinary fabrics offer practically no protection against mustard gas or lewisite. Rubber and oilcloth, for example, will be penetrated within a short time. The longer the period during which they are exposed, the greater the danger of wearing these articles. Rubber boots worn in an area contaminated with mustard gas may offer a grave danger to men who wear them several days after the bombardment. Impermeable clothing will resist penetration more than an hour, but should not be worn longer than this.

**168. Cleaning.**—*a.* All unpainted metal parts of matériel that have been exposed to any gas except mustard and lewisite must be cleaned as soon as possible with solvent, dry-cleaning, or alcohol, denatured, and wiped dry. All parts should then be coated with engine oil.

*b.* Ammunition which has been exposed to gas must be thoroughly cleaned before it can be fired. To clean ammunition use agent, decontaminating, noncorrosive, or if this is not available, strong soap and

cool water. After cleaning, wipe all ammunition dry with clean rags. *Do not use dry powdered agent, decontaminating (chloride of lime) (used for decontaminating certain types of matériel on or near ammunition supplies), as flaming occurs through the use of chloride of lime on liquid mustard.*

**169. Decontamination.**—For the removal of liquid chemicals (mustard, lewisite, etc.) from matériel, the following steps should be taken:

*a. Protective measures.*—(1) For all of these operations a complete suit of impermeable clothing and a service gas mask will be worn. Immediately after removal of the suit, a thorough bath with soap and water (preferably hot) must be taken. If any skin areas have come in contact with mustard, if even a very small drop of mustard gets into the eye, or if the vapor of mustard has been inhaled, it is imperative that complete first-aid measures be given within 20 to 30 minutes after exposure. First-aid instructions are given in TM 9-850 and FM 21-40.

(2) Garments exposed to mustard will be decontaminated. If the impermeable clothing has been exposed to vapor only, it may be decontaminated by hanging in the open air, preferably in sunlight, for several days. It may also be cleaned by steaming for 2 hours. If the impermeable clothing has been contaminated with liquid mustard, steaming for 6 to 8 hours will be required. Various kinds of steaming devices can be improvised from materials available in the field.

*b. Procedure.*—(1) Commence by freeing matériel of dirt through the use of sticks, rags, etc., which must be burned or buried immediately after this operation.

(2) If the surface of the matériel is coated with grease or heavy oil, this grease or oil should be removed before decontamination is begun. Solvent, dry-cleaning, or other available solvents for oil should be used with rags attached to ends of sticks.

(3) Decontaminate the painted surfaces of the matériel with bleaching solution made by mixing one part agent, decontaminating (chloride of lime), with one part water. This solution should be swabbed over all surfaces. Wash off thoroughly with water, then dry and oil all surfaces.

(4) All unpainted metal parts and instruments exposed to mustard or lewisite must be decontaminated with agent, decontaminating, non-corrosive, mixed one part solid to 15 parts solvent (acetylene tetrachloride). If this is not available, use warm water and soap. Bleaching solution must not be used, because of its corrosive action. Instrument lenses may be cleaned only with paper, lens, tissue, using a small

amount of alcohol, ethyl. Coat all metal surfaces lightly with engine oil.

(5) In the event agent, decontaminating (chloride of lime), is not available, matériel may be temporarily cleaned with large volumes of hot water. However, mustard lying in joints or in leather or canvas webbing is not removed by this procedure and will remain a constant source of danger until the matériel can be properly decontaminated. All mustard washed from matériel in this manner lies unchanged on the ground, necessitating that the contaminated area be plainly marked with warning signs before abandonment.

(6) The cleaning or decontaminating of matériel contaminated with lewisite will wash arsenic compounds into the soil, poisoning many water supplies in the locality for either men or animals.

(7) Leather or canvas webbing that has been contaminated should be scrubbed thoroughly with bleaching solution. In the event this treatment is insufficient, it may be necessary to burn or bury such matériel.

(8) Detailed information on decontamination is contained in FM 21-40, TM 9-850, and TC 38, 1941.

APPENDIX

LIST OF REFERENCES

1. Standard Nomenclature Lists.

*a. Ammunition.*

Ammunition, fixed, including subcaliber--- SNL P-4  
 Ammunition, rifle and automatic gun----- SNL T-1

*b. Cleaning, preserving and lubricating materials.*----- SNL K-1

*c. Gun matériel.*

Generating unit M5----- SNL F-227  
 Gun, automatic, 37-mm, M1A2 and car-  
 riages, automatic gun, 37-mm, M3, M3A1  
 and M3E1----- SNL A-29

*d. Fire control.*

AA director M5----- SNL F-205  
 Remote control system M1----- SNL F-208  
 Set, control equipment, automatic gun, AA,  
 M1 (for 37-mm automatic gun and cal.  
 .50 AA machine gun)----- SNL F-182  
 Sighting system M2----- SNL F-183

*e. Machine guns.*

Gun, machine, cal. .30, Browning, M1917  
 and M1917A1----- SNL A-5  
 Gun, machine, cal. .50, Browning, M2,  
 water-cooled, flexible----- SNL A-37

*f.* Current Standard Nomenclature Lists are as tabulated here. An up-to-date list of SNL's is maintained as the "Ordnance Publications for Supply Index" (OPSI).

2. Explanatory publications.

*a. Artillery ammunition.*----- OS 9-20  
*b. Cleaning, preserving, and lubricating materials.*----- TM 9-850  
*c. Fire control.*  
 Set, control equipment, M1----- TM 9-1605  
 Sighting system M2----- TM 9-1606

37-MM AA GUN MATÉRIEL

*d. Gun matériel.*

Generating unit M5----- Instruction book  
in pocket inside  
instrument panel  
door

Gunnery, fire-control, and position finding,  
antiaircraft automatic weapons----- FM 4-112

Service of the piece, 37-mm antiaircraft gun----- FM 4-140

*e. Lubrication.*

Gun, automatic, 37-mm, M1A2----- OFSB 6-A-29

Gun, automatic, 37-mm, M1A2----- Lubrication Guide

*f. Machine guns.*

Browning machine gun, caliber .30, M1917-- FM 23-55

Browning machine gun, caliber .50, M2,  
fixed and flexible----- TM 9-226

*g. Introduction to ordnance storage and shipment* Section (a)  
charts----- IOSSC

**3. Firing tables.**

*a. Gun, automatic, 37-mm, M1A2.*

Shell, fixed, HE, M54----- FT 37AA-N-2

Shell, fixed, practice, M55----- FT 37AA-N-2

*b. Current firing tables are as tabulated here.* An up-to-date list  
of firing tables is maintained in SNL F-69.





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[A. G. 062.11 (5-8-42).]

BY ORDER OF THE SECRETARY OF WAR:

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J. A. ULIO,  
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(For explanation of symbols see FM 21-6.)

